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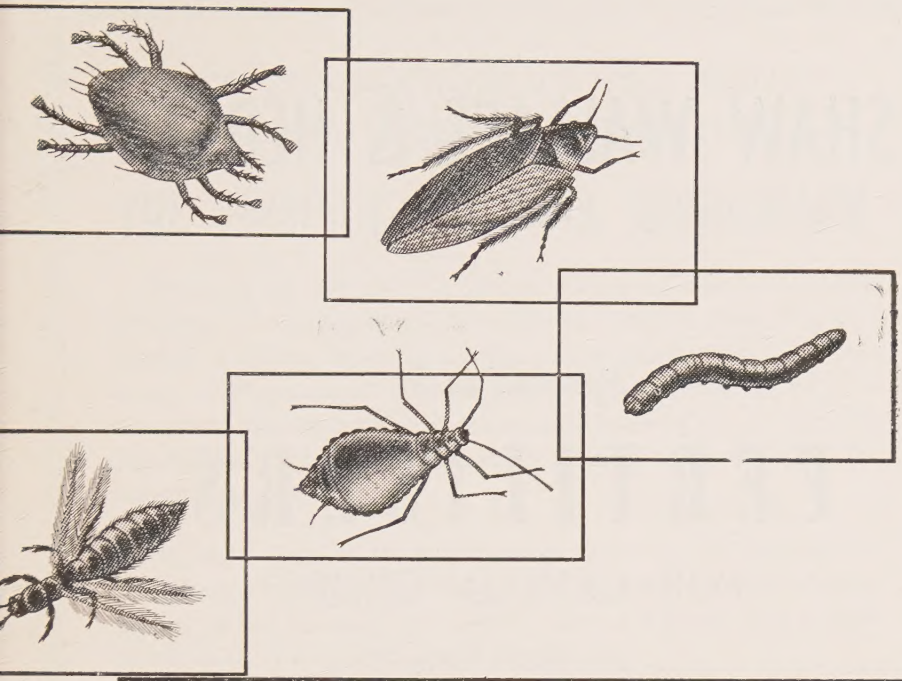

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DR. M. F. CHANDRARATNA

Director of Agriculture

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CONTENTS

Page

EDITORIAL

Self-sufficiency in Potatoes 1

PHOTOTAXIC RESPONSE IN THE RHINOCEROS BEETLE (ORYCTES RHINOCEROS *L*)

by Hilary F. Goonewardena, Crop Protection Officer, Coconut Research Institute, Ceylon 5

THE CULTURE OF FLOWERING PLANTS IN THE LOW AND MID COUNTRY OF CEYLON

by D. T. Ekanayake, Assistant Superintendent, Botanic Gardens .. 13

MIXED BORDERS FOR GARDENS IN THE HILL COUNTRY

by D. T. Ekanayake, Assistant Superintendent, Botanic Gardens .. 19

A NOTE ON STORAGE TESTS ON PADDY

by C. Charavanapavan, Department of Agriculture, Ceylon .. 27

BEE KEEPING FOR HONEY PRODUCTION—A STUDY OF THE FACTORS INVOLVED

by L. A. S. Perera, Department of Agriculture, Ceylon .. 31

PARASITIC INFESTATIONS OF ANIMALS

by Sir Thomas Dalling, Consultant of the Food and Agriculture Organisation of the United Nations (FAO) Rome, Italy .. 47

VETERINARY EDUCATION

by Sir Thomas Dalling, Consultant of the Food and Agriculture Organisation of the United Nations (FAO) Rome, Italy .. 57

METEOROLOGICAL REPORT

Summary for January to March, 1960 65

Practical field tests, carried out in Ceylon, have shown that the loss of paddy may be averted by the use of 'Gammexane' Dust D. .120

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EDITORIAL

Self-sufficiency in Potatoes

IN the April-June, 1958, issue of the "Tropical Agriculturist", the Editor expressed the conviction that, in certain well-defined climatic regions in Ceylon, the prospects of potato growing were exceptionally bright, and that self-sufficiency in potatoes, imports of which at present cost the country nearly 16 million rupees, was a tangible objective. The report submitted by Dr. Pushkarnath, Director of the Central Potato Research Institute, Simla, who visited Ceylon in that year, under the auspices of Colombo Plan, provided the blueprint for a potato industry independent of foreign seed supplies. Ceylon has had the benefit of a second visit by Dr. Pushkarnath during the period, February-March, 1960, and a review, on this occasion, of the advances achieved in potato growing since 1958 appears relevant. Dr. Pushkarnath's report on his second visit has yet not been formally received by the Ceylon Government, but his views were lucidly and cogently stated in his address to the National Planning Council.

Ceylon's nascent potato industry has been fortunate that its guiding genius is an officer as technically competent and as administratively capable as the present Research Co-ordinator, Rahangala. His disease surveys indicate that at elevations above 5,000 ft., bacterial wilt is conspicuously absent, and degenerative virus diseases refreshingly scarce. Regular records maintained by him revealed a surprisingly low level of infestation by the aphids which function as virus vectors. These data justify the establishment of seed stations at Sita Eliya, Galpalama, Pidurutalagala, Kandapola, Ragala, Meepilimana and Uda Radella. These eight stations, all of which are located at elevations over 5,000 ft., will cover an acreage of 1,000 ; an extent of about 500 acres would, however, saturate the Island's seed potato requirements.

The foundation stock for these seed stations consisted of 30 tons of certified seed of the varieties, Up-to-date, Gineke and Tedria introduced from Scotland and the Netherlands. Earlier trials revealed that Up-to-date produced heavy yields of high-quality potatoes, but succumbed to late blight. Gineke and Tedria resisted late blight but were strikingly inferior to Up-to-date in quality and yield. In the

early stages of the development of the industry, the issue of Up-to-date seed will be limited to seasons in which late blight is not troublesome. Although seed production is completely confined to the stations listed above, commercial potato growing will extend to elevations considerably below 5,000 ft. The rule enunciated by Dr. Pushkarnath that movement of seed potatoes be permitted only to areas below the seed stations is being rigidly followed.

A scrutiny of the rainfall patterns in the areas earmarked for potato development reveals fascinating possibilities : not only does irrigation appear unnecessary, but in most areas, the precipitation permits the harvesting of three potato crops per year. Triple cropping will (*a*) reduce the physical acreage needed for self-sufficiency, (*b*) minimize difficulties connected with seed dormancy, and (*c*) simplify storage problems. Dr. Pushkarnath estimates that, with judicious triple cropping, an acreage of 4,000 is all that would be needed to raise annually the 40,000 tons of potatoes that Ceylon at present imports.

The Department has initially confined the programme of potato extension to Ragala, Kandapola, and Sita Eliya, where the relatively dry southwest-monsoon season makes late blight a negligible hazard. Farmers in these areas who received sprouted seed from Departmental Seed Stations at 35 cents per lb., found potatoes a particularly lucrative crop. Yields often reached 10 tons per acre. Even at average yields of five tons per acre, and at the present wholesale price of Rs. 520 per ton, the nett return per acre approximates Rs. 1,600 per acre per 3-months season. There is little doubt that the total commercial acreage needed for self-sufficiency in potatoes will materialize as soon as the Department's plans for the supply of clean and inexpensive seed come into fruition. If the present pace of progress persists Ceylon should reach self-sufficiency in both seed and consumption potatoes by the end of 1961.

The complete prohibition of imports of both seed and consumption potatoes as soon as self-sufficiency is achieved is vital for the survival of this vulnerable industry. Continued imports would permit the introduction and dissemination of the multiplicity of diseases that plague this crop, and the effects on commercial potato growing will certainly be ruinous.

As payment for seed is the largest item in the costs of potato growing, the provision of credit facilities would contribute considerably to the use of certified seed, and consequently to crop sanitation. Perhaps the most satisfactory assistance that the grower can receive

is the loan of seed recoverable in kind at harvest. This assistance can be most conveniently furnished to him by the co-operatives that market his crop.

As production rises, the need for a guarantee of price will be increasingly felt. As, however, the present annual per capita consumption of 9.4 lb. represents only a fraction of the real needs, the acreage can continue to expand for many years to come with no danger of overproduction. Moreover, expansion in potato production is likely to be reflected in a reduction in Ceylon's rice requirements. These production trends can continue, however, only if imports are halted at the crucial stage indicated earlier. In his address to the National Planning Council, Dr. Pushkarnath made an impassioned plea for a total ban on potato imports in early 1962.

PHOTOTAXIC RESPONSE IN THE RHINOCEROS BEETLE
(Oryctes rhinoceros L.)

By

HILARY F. GOONEWARDENA

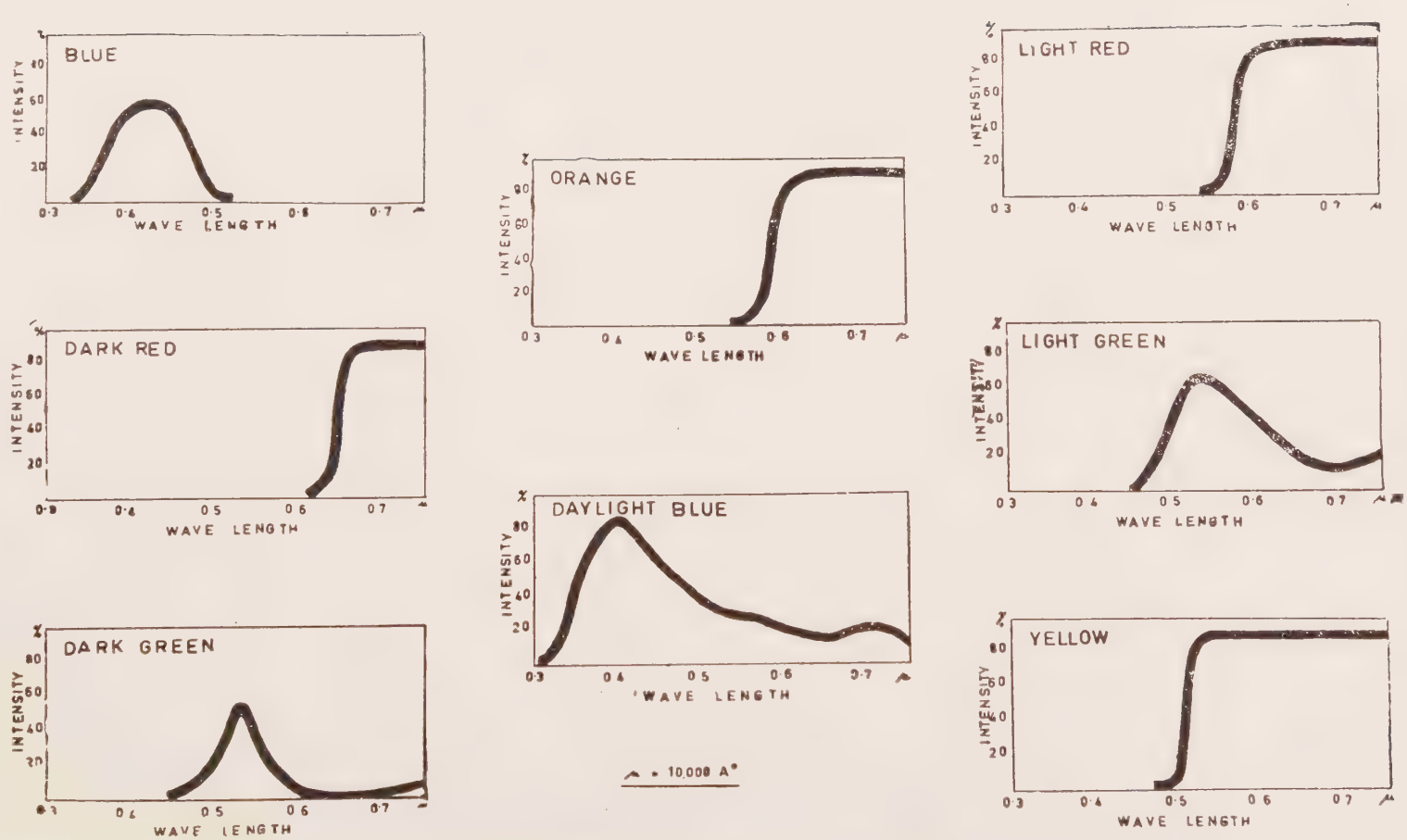
Crop Protection Officer, Coconut Research Institute, Ceylon

THE investigation reported herein was designed to determine the response of *Oryctes rhinoceros* L. to light of various wave lengths. It appeared likely that the results would be of value in devising a light trap that would be effective in the control of *Oryctes*. White light was broken up into the following colours by using appropriate filters :—Daylight Blue, Light Red, Orange, Light Green, Dark Blue, Dark Red, Purple, Dark Green, Light Neutral, Day Natural, Yellow.

The filters were those supplied by C. Baker of Holborn, Ltd., for use in microscope lamps. The colour transmission curves for the various filters as supplied by the manufacturers are reproduced below. Manufacturers state that " each curve is the mean curve for the type in question." These colours were compared separately with the ground-glass filter which permitted the transmission of white light.

Apparatus :

A box made of $\frac{1}{2}$ in. wood and measuring $21\frac{1}{2}$ in. $\times$ $21\frac{1}{2}$ in. was divided into three compartments by two sloping partitions. The two outer compartments were 9 in. wide at the top and 6 in. wide at the bottom. The sides of the centre compartments were $3\frac{1}{2}$ in. apart at the top and $9\frac{1}{2}$ in. apart at the bottom. The centre compartment sides had two glass panels. Each panel was 14 in. long and 2 in. broad. The sides of the centre compartment were fitted with flaps measuring $1\frac{1}{2}$ in. $\times$ $20\frac{1}{2}$ in., that opened outwards. The lid of the box was made in three sections and was secured by wooden catches. The lids of the outer compartments measured $21\frac{1}{2}$ in. $\times$ $9\frac{1}{2}$ in. and the lid of the centre compartment measured $21\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in. On the lids of the outer compartments were two square frames measuring 2 in. $\times$ 2 in. into which the filters fitted.



Colour transmission curves of some of the filters used.

FIG 1

FIG 2

FIG 3

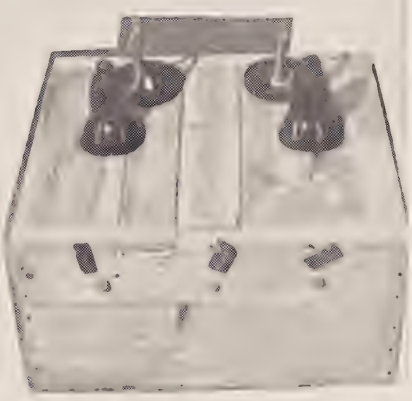


FIG 4

(1) Box with lid removed.

(2) Box with centre section of lid retracted.

(3) Box with the sections of the lid covering the centre and an outer compartment removed to expose glass pane.

(4) Box with lamps in position.

Two 40-watt angle-poise lamps were used as sources of light which was directed through the filters, into the two outer compartments. Some of this light passed into the centre compartment through the glass panels.

Procedure :

IN the centre compartment of the apparatus described above, the beetles along with 4 in. pieces of coconut petiole were without any illumination for 72 hours. The feeding material was renewed daily. The lamps were then switched on for 48 hours while the beetles were still confined to the centre compartment. The lamps were then switched off for a further period of 24 hours. Beetles were replaced as necessary. The filters were then placed in position, the checks confining the beetles to the centre compartment were removed, food was introduced into all three compartments, and the lights switched on. The beetles were exposed to the light sources for 24 hours. At the end of this period the number of beetles found in each compartment was counted and their sex noted. For the next 24-hour period the beetles were subjected to complete darkness and were confined to the centre compartment. In this way the beetles were exposed to the various wave lengths for a period of 24 hours, only. A period of total darkness intervened between two successive periods of exposure, and during this period the beetles were confined to the centre compartment.

Design of Experiment :

IN the first series the ground glass filter was placed in the frame on the left-hand side lid, and the coloured filter in the frame on the right-hand side lid. The colour filters were chosen at random.

The sequence was as follows :—

Left-hand side		*Right-hand side*
Ground glass	vs.	Daylight blue
Ground glass	vs.	Dark blue
Ground glass	vs.	Light neutral
Ground glass	vs.	Light red
Ground glass	vs.	Dark red
Ground glass	vs.	Day neutral
Ground glass	vs.	Orange
Ground glass	vs.	Purple
Ground glass	vs.	Yellow
Ground glass	vs.	Light green
Ground glass	vs.	Dark green

The same routine was followed in the second series.

The sequence of filters used was as follows :—

Left-hand side		*Right-hand side*
Ground glass	vs.	Yellow
Ground glass	vs.	Day Neutral
Ground glass	vs.	Dark red
Ground glass	vs.	Light red
Ground glass	vs.	Daylight blue
Ground glass	vs.	Light neutral
Ground glass	vs.	Orange
Ground glass	vs.	Dark blue
Ground glass	vs.	Light green
Ground glass	vs.	Dark green
Ground glass	vs.	Purple

In the two previous series the ground glass filter (standard) was always placed in the left-hand side frame of the lid. In the third series, the ground-glass filter was changed from the left-hand side to the right-hand side with every alternative exposure. The sequence was as follows :—

Left-hand side		*Right-hand side*
Yellow	vs.	Ground glass
Ground glass	vs.	Day neutral
Dark Red	vs.	Ground glass
Ground glass	vs.	Light red
Daylight blue	vs.	Ground glass
Ground glass	vs.	Light neutral
Orange	vs.	Ground glass
Ground glass	vs.	Dark blue
Light green	vs.	Ground glass
Ground glass	vs.	Dark green
Purple	vs.	Ground glass

Results :

THE results obtained are presented in Table I.

TABLE I

Beetle counts taken in three compartments of the apparatus during the 24-hour period of exposure

Series	*Beetles used in Export*			*Ground glass*			*Daylight blue*		
	Total	*Male*	*Female*	*Total*	*Male*	*Female*	*Total*	*Male*	*Female*
1	39	21	18	18	10	8	11	3	8
2	13	8	5	6	3	3	6	4	2
3	12	8	4	2	1	1	4	2	2

							Dark blue		
1	37	20	17	6	3	3	4	2	2
2	11	8	3	4	2	2	5	4	1
3	10	6	4	1	0	1	3	2	1

TABLE I—(contd.)

Beetle counts taken in three compartments of the apparatus during the 24-hour period of exposure—*contd.*

Series	*Beetles used in Export*			*Ground glass*			*Daylight blue*		
	Total	*Male*	*Female*	*Total*	*Male*	*Female*	*Total*	*Male*	*Female*
							Light Neutral		
1	32	15	17	15	5	10	6	3	3
2	15	8	7	6	4	2	5	2	3
3	14	8	6	1	1	0	6	4	2
							Light Red		
1	29	14	15	12	4	8	13	6	7
2	14	9	5	5	3	2	8	5	3
3	11	7	4	2	1	1	7	4	3
							Dark Red		
1	24	12	12	8	4	4	12	5	7
2	15	9	6	4	3	1	7	5	2
3	15	10	5	3	3	0	10	6	4
							Day Neutral		
1	24	7	17	4	2	2	9	2	7
2	15	5	10	5	0	5	5	1	4
3	13	7	6	7	4	3	2	1	1
							Orange		
1	20	8	12	8	3	5	11	5	6
2	12	9	3	7	5	2	1	0	1
3	12	7	5	5	2	3	1	1	0
							Purple		
1	25	9	16	5	1	4	5	0	5
2	11	6	5	3	2	1	6	3	3
3	6	4	2	0	0	0	4	2	2
							Yellow		
1	18	8	10	8	3	5	4	0	4
2	15	5	10	4	1	3	4	0	4
3	12	7	5	3	2	1	6	2	4
							Light Green		
1	18	6	12	8	2	6	4	0	4
2	12	8	4	6	2	4	4	4	0
3	9	6	3	3	2	1	1	1	0
							Dark Green		
1	16	6	10	6	5	1	4	0	4
2	13	8	5	5	2	3	3	1	2
3	8	5	3	1	1	0	4	1	3

Percentages of beetles attracted by various colours are given in Table 2. The data after transformation to the inverse sine scale appropriate to a binomial distribution have been subjected to an analysis of variance.

TABLE II

Percentage of beetles attracted to the different colours

Colour	*Replicate I*		*Replicate II*		*Replicate III*	
	Males	*Females*	*Males*	*Females*	*Males*	*Females*
Blue	12·2	28·1	50·0	36·7	29·2	37·5
Neutral (light and day)	24·3	29·4	22·5	41·4	32·2	25·0
Red	42·3	52·5	55·6	46·7	58·6	77·5
Green	0·0	36·7	31·3	20·0	18·4	50·0
Orange	62·5	50·0	0·0	33·3	14·3	0·0
Purple	0·0	31·3	50·0	60·0	50·0	100·0
Yellow	0·0	40·0	0·0	40·0	28·6	80·0

TABLE III

Analysis of Variance of Transformed Data ($\theta = \sin^{-1}\sqrt{P}$)

Source	*D. F.*	*S. S.*	*M. S.*	*F.*
Replicates	2	887	444	2·08
Main effects:				
Colour	6	2,469	412	1·93
Sex	1	1,349	1,349	6·33*
Interactions:				
Colour and Sex	6	1,274	212	—
Error	26	5,537	213	—
Total	41	11,516	—	—

S.E. of mean $\pm 5{\cdot}958$
S. E. of difference between 2 treatments means $= \pm 4{\cdot}214$.
Critical difference $= 8{\cdot}7$.

TABLE IV

Treatment means

Colour	*Mean*	
	Sine	%*
Red	34·3	56·4
Purple	34·0	55·9
Yellow	19·7	33·7
Blue	19·0	32·6
Neutral (light and day)	17·0	29·2
Orange	16·2	27·9
Green	15·5	26·7

*Re-transformed.

TABLE V

Sex means

Sex	*Mean*	
	Sine	%*
Male	16·6 ..	28·6
Female	27·9 ..	46·8

*Re-transformed.

Conclusions :

THE following conclusions stem from the statistical analysis :—

(i) The red and purple coloured beams are significantly better than the other colours. The red is relatively more reliable than purple because the purple is based on a fewer number of beetles.

(ii) There is no significant difference between red and purple.

(iii) Yellow, blue, neutral (light and day), orange and green did not differ significantly among themselves.

(iv) Sex difference highly significant, i.e., females are more attracted to all colours.

(v) Sex × colour interaction is not significant. This means that there is no sex bias towards a particular colour or colours.

Acknowledgments :

THANKS are due to Mr. V. Abeywardene for the statistical analysis of the results and to Mr. D. B. Hettiaratchchi for the photographs.

THE CULTURE OF FLOWERING PLANTS IN THE LOW AND MID COUNTRY OF CEYLON

By

D. T. EKANAYAKE

Assistant Superintendent, Botanic Gardens

CLIMATE

AS is well known, climatic factors influence plant growth profoundly. The Low Country of Ceylon extends from sea level up to about 1,500 ft. elevation. Here, the shade temperature is about 85°F., and the rainfall is about 80-120 inches, well distributed throughout the year. The Mid Country extends from 1,500 ft. up to about 4,000 ft. elevation. The rainfall is heavy, and the temperature is mild. Day length varies from 11.5 hours to 12.5 hours. Most of the annuals grown in the low and medium elevations are temperate or sub-tropical in origin, and hence their cultivation in Ceylon requires special attention. Planting should be arranged in such a way that flowering occurs during the dry spells. Wet weather generally spoils blooms as well as retards the formation of flower buds. The dry season in most parts of the island is from March to May. The growing period up to the formation of flowers varies in different species of flowering plants. Annuals like Phlox and Petunia take about 3 or 4 months to flower, while Zinnia takes only about 6 weeks. When planting annuals or perennials, it is advisable to avoid heavy rains. However, light showers are beneficial for their establishment. Unlike in the hot, humid low country, a wide range of annuals and perennials can be grown in the mild mid country. The large-flowered Dahlia thrives at Peradeniya, and produces excellent blooms. In Colombo, the cultivation of the large flowered Dahlia is extremely difficult.

PREPARATION OF FLOWER BEDS

MUCH depends on the initial perparation of flower beds. Most of the commonly cultivated annuals and perennials require a rich, well-drained soil. The soil should be well dug, and where the soil is very

sandy as in certain areas in Colombo, the top soil should be dressed with some clayey soil. Where the soil is heavy sufficient sand should be added. A dressing of lime improves clayey and acid soils. Generally a dressing of lime is recommended before manuring the flower beds. Later well rotted cattle manure and leaf mould should be incorporated into the soil, and the level of soil in the bed should be raised 2 or 3 inches above ground level. This facilitates drainage, and contributes to better display of plants and flowers. In the dry zone, however, the level of soil should be lowered a few inches below ground level to conserve moisture.

PROPAGATION OF ANNUALS

ANNUALS are generally propagated from seed. When temperate annuals are grown in tropical countries, the quality of the flowers degenerates in successive generations. Therefore, for better results, seeds have to be imported for every new planting season.

Boxes are the best for germinating annuals. These seed boxes can be made of old packing cases. The normal size of a seed box is 20 in. × 13 in. × 4 in. (Fig. 1). Seeds may also be sown in pans. Drainage holes should be provided both in boxes and pans. The soil medium for sowing seeds is made up as follows :

2 parts sifted loam,
1 part leaf mould,
1 part sand.

Before filling the boxes with sand, crocks should be placed at the bottom of the box for drainage (Fig. 2). Over the crocks, a layer of dry leaves is placed (Fig. 3). The box is then filled and surface levelled with a flat piece of wood (Fig. 4). The seeds should be sown on the levelled surface, and covered with a thin layer of soil. (Fig. 5). Generally large seeds are sown just below the surface. In the case of tiny seeds, only a sprinkling of sand on top is necessary. After sowing, the seed boxes are watered with a can provided with a fine rose. (Fig. 6). In the case of very small seeds, overhead watering is not desirable. Hence, the boxes may be placed in water which is allowed to seep up. The time taken for the seeds to germinate depends on the respective varieties. Some varieties like Phlox take about 2 weeks to germinate, while others like Zinnia take only 2 or 3 days. It is important to protect the young seedlings from excessive sunlight. However, they should not be kept under deep shade. The seedlings should be exposed to the morning sun. Great care should be taken when watering the seedlings. Excessive watering causes " damping off ", the fungus attacking seedlings just above ground level causing

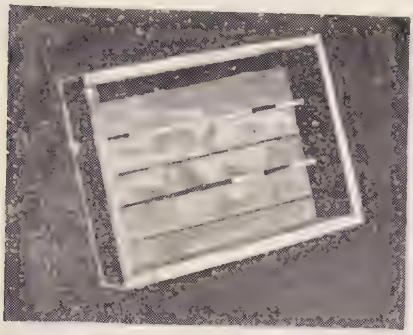


FIG. 1.

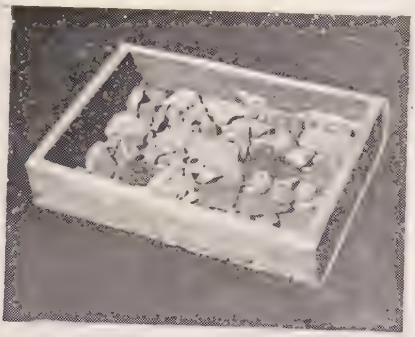


FIG. 2.

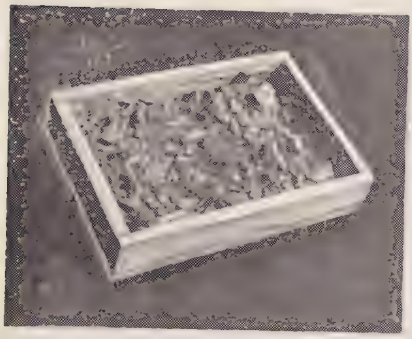


FIG. 3.

FIG. 4.

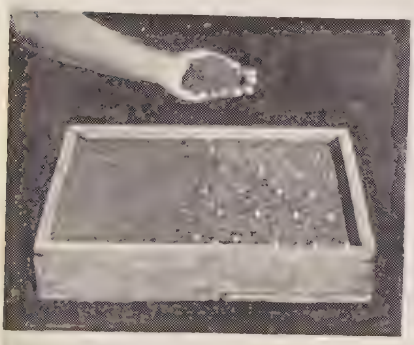


FIG. 5.

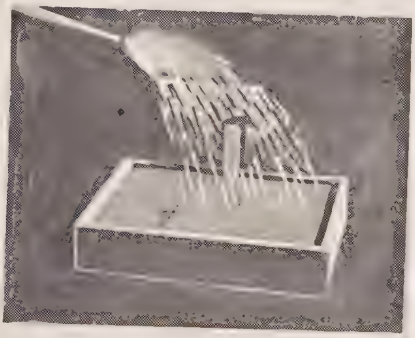


FIG. 6.

(1) Seed box.
(2) Seed box with crocks placed at bottom.
(3) Seed box with layer of dry leaves over crocks.
(4) Levelling surface of seed box over crocks.
(5) Covering seed with a thin layer of soil.
(6) Watering seed box.

the seedlings to fall over. The disease is very common during wet weather. When the seedlings are about 2 or 3 inches high, they should be transplanted in beds.

CARE OF SEEDLINGS AND ADULT PLANTS

AFTER planting in beds, the seedlings should be shaded from excessive sunlight till they are established. When the seedlings are established, regular tillage is essential. Forking the soil around the plants facilitates the admission of air into the spaces between the soil particles. Secondly, tillage improves the water absorption capacity of the soil, and finally tillage helps in the penetration of roots in the soil.

Watering the seedlings and adult plants is necessary during dry weather. But the soil should be examined before watering to check wether the soil is damp. Some plants are deep feeders and although the surface soil may appear dry, the deeper soil layers may contain sufficient water for the plants. In such cases it is not advisable to water the plants, as excessive dampness in the soil causes a condition called physiological drought. Physiological drought causes the plants to wilt due to lack of air. In general, plants should not be allowed to suffer due to lack of water, but should be watered only when they need water.

ARTIFICIAL MANURE FOR GARDEN FLOWERS

AN application of a fertilizer mixture is beneficial during the growing period of the plants. The following mixture has been found satisfactory in all areas in Ceylon—

2 parts sulphate of ammonia,
2 parts superphosphate,
1 part sulphate of potash.

This mixture should be applied at the rate of 3 oz. per sq. yard. After application, the beds should be heavily watered. In the alternative, an application of a liquid fertilizer like Hyponex is recommended.

PESTS OF GARDEN FLOWERS

Slugs and snails: They are troublesome pests, especially when the plants are small. Slugs and snails are abundant during wet weather, and a vigorously growing group of seedlings is liable to be destroyed overnight by them. They are best destroyed by using one of the proprietary brands of slug bait.

Insects : These insects are controlled by hand picking or by using suitable insecticides. The control of insects with the aid of insecticides depends on the feeding habits of insects. Insects are divided into two groups depending on their feeding habits.

(*a*) Biting insects.
(*b*) Sucking insects.

Biting insects are destroyed by using stomach poisons, while sucking insects are destroyed by using contact poisons. The most troublesome biting insects attacking garden flowers are caterpillars, beetles, cut-worms, maggots, and beetle larvæ. These insect usually bite the young leaves and buds of plants. If they attack flower buds and flowers, they should be controlled by hand picking, as spraying an insecticide may damage the flowers. Biting insects in foliage are generally controlled by lead arsenate spray which is made up as follows :

Lead arsenate	..	1 oz.
Water	..	1 gallon.

The disadvantage of spraying the plants with lead arsenate is that the spray leaves a white stain on the foliage. Cut-worms are destroyed by using insecticides like Intox 8 or Aldrin.

The most troublesome sucking insects among garden flowers are aphids and other greenfly, mealy bugs, scale insects and capsid bugs. Scale and capsid insects are very resistant to insecticides, and special insecticides have to be used against them. Sucking insects are destroyed by using Nicotine sulphate, D. D. T. Gammexane and Basudin 60. Red spider which is a troublesome pest during dry weather is controlled by using insecticides like " Fernasul " or " Thiovit ".

DISEASES OF GARDEN PLANTS

DISEASES in garden plants are few compared to pests. In most cases these diseases are peculiar to certain genera, species and varieties.

Damping Off : This is a very common disease in seedlings caused by soil-borne fungi. The disease is observed during wet weather. The first sign of the disease is wilting followed by a constriction of the plant at ground level. This is brought about by the destruction of the outer tissues of the plant by fungi. The disease is encouraged by damp soil. The disease is controlled by using sterilised compost for sowing seeds. An alternative method of control is by watering the seed boxes with Cheshunt Compound which is made up as follows :

Ammonium carbonate	..	11 parts.
Copper sulphate	..	2 parts.

The two chemicals are mixed, and allowed to stand for 24 hours in a sealed tube. The solution for watering is prepared by dissolving 1 oz. of the mixed powder in 2 gallons of water.

In addition to damping off, there are several other plant diseases such as mildew, leafspot, blight, rust, rot and virus diseases. Mildews form yellowish patches on the upper surface of leaves and a powdery growth on the lower surface. Mildews are caused by fungi. In leafspot, certain areas of the leaves are destroyed by fungi causing spots. Blight causes the leaves to wilt, wither and decay. This is caused by fungi as well as bacteria. In rots, the stem becomes soft giving out a putrid odour. Virus diseases are caused by minute organisms. But methods have not yet been determined to control them. Usually virus diseases are spread by insects. In such cases, the virus disease is controlled by checking the insect vector.

Most of the plant diseases caused by fungi are controlled by the use of fungicides. Plant diseases could be controlled by the well known Bordeaux Mixture which is made up as follows :

Copper sulphate	..	5 lb.
Quick lime	..	5 lb.
Water	..	50 gallons.

The Copper sulphate and quick lime are dissolved in water separately. The two chemicals should be mixed in a wooden container, and the remainder of water added.

A number of proprietary brands of Copper fungicides are available in the market. Copper fungicides are suitable for the control of most fungal diseases including leafspot. In general, Sulphur in the wettable form is an effective remedy for most fungal diseases.

Bacterial wilt is one of the most difficult diseases to control. Wilt has been observed in Zinnia. In such cases, the wilted plants should be removed and destroyed immediately, else the disease may spread into healthy plants. In recent years, antibiotics like Streptomycin have been used to control bacterial wilt.

MIXED BORDERS FOR GARDENS IN THE HILL COUNTRY

By

D. T. EKANAYAKE

Assistant Superintendent, Botanic Gardens

THE annual and perennial border commonly called the mixed border is a characteristic feature in hill country gardens. A mixed border is easy to maintain unlike beds of annuals which need a lot of labour for general upkeep. Such a border once planted lasts several years, and requires very little attention except annual forking and manuring, planting annuals for the Nuwara Eliya season, occasional division and replanting of perennials, and weeding. A wide range of annuals and perennials of temperate origin can be grown successfully at the higher elevations, and hence a well constructed border is ideal for the display of a mass of colour.

SITUATION, ASPECT AND SOIL

A FLOWER border may be established at the edge of a lawn, around the verandah of a house or along a drive or path, but one should consider the availability of light and protection from strong wind in the selection of a site. In the hill-country, it is best to allow the border to face due east wherever possible to enable the plants to benefit by the morning sun. A hedge may be established at the back of the border to protect the plants from strong south-westerly winds which prevail in this part of the country during June and July. This hedge should not be planted too close to the border as roots from the hedge plants may interfere and compete for nourishment. In addition to the hedge, a suitable background where necessary may be established. The background may take the form of a fence or a trellis covered with a rambler rose like '*Euphrosyne*'.

Garden annuals and perennials grow in almost any soil, but a deep rich loamy soil is preferred. The hill-country soils are ideal for borders, and require very little amendment for growing annuals and perennials.

CONSTRUCTION OF THE BORDER

A BORDER is constructed to last many years, and skilful planning, construction and planting are required at the very start. The width of the border depends on the amount of space available and the position. Generally, a border should not be less than 4 feet or more than 12 feet wide. An 8ft. border is ideal. A border exceeding 12 feet is not recommended as routine garden operations like weeding, manuring, forking and watering are rendered inconvenient.

The selected site should be well drained, and then dug and trenched to a depth of about 2-2½ feet. The subsoil should not be brought to surface. If the subsoil is clayey in nature, sufficient sand and some lime may be incorporated. The topsoil should be mixed with well-decomposed farmyard manure and leaf mould. If the topsoil is clayey, sufficient sand and a large volume of leaf mould should be added. If the topsoil is too sandy, well pulverised clay should be worked in. The level of soil in the border should be raised a few inches above ground level for better drainage and better display of flowers.

COLOUR HARMONY IN THE BORDER

COLOUR harmony and colour grouping are two of the most important aspects of border construction. Grouping colours should be done in such a way that the tints merge from one into the other from the pale to the most brilliant shades. It is best to avoid contrasts in colour, as such a grouping is not pleasing to the eye.

There are four main colour groups in garden flowers namely, red, yellow, blue and purple. In between these colours, there are intermediate hues like pink, orange, crimson and lilac. The red group should be arranged as follows : start with pale pinks, and next to them insert the dark pinks followed by the crimsons and deep reds. From this zenith, proceed backwards to pale pinks again. The yellow, blue and purple groups should be similarly arranged. Next is the question of the arrangement of these four groups in harmony. Pale pinks and pale yellows go well side by side, and thus they can join the red group to the yellow. Again pale blues and pale yellows can be juxtaposed, and thus : the blue group can pass into a yellow group. Pale pink and lilac go well with each other, and hence they can join a purple group to the red group. It is also possible to harmonize colours by allowing them to lead from one to the other. For instance, the yellows can merge into orange, orange to orange-scarlet and scarlet, and scarlet to crimson. Similarly, pale blues lead to dark blues, then purple and down through lilac to pale blue. White occupies a very important

place in the border as it helps in difficult situations. White can be placed in between contrasting colours as well as between pale and well matching colours.

ARRANGEMENT OF PLANTS ACCORDING TO HEIGHT

IN addition to colour harmony, correct gradation of height of the respective plants in the groupings has an important role. Generally, the taller plants like African Marigold, Delphiniums, Everlasting, Hollyhock and *Salvia splendens* are planted at the back through a gentle gradation of plants of medium height like Penstemons, Schizanthus, Balsams, Silene, Campanulas, Michaelmas Daisies, Poppies and Sweet Williams to dwarfs like Violets, Verbena, Alyssum, Candytuft and Begonia in front. This scheme should not be followed indefinitely, taller plants should be interpolated among dwarf species to ensure variety. Similarly, dwarf stragglers like Verbena should be allowed to find their way into groups of taller growing species. Irregularity tends to hide one section of the border from the other, a factor which lends the border charm and beauty.

PLANTING BORDERS IN HILL COUNTRY GARDENS

THERE are two principal dry seasons in the hill country of Ceylon namely, the main March-April dry season and a second dry season in August. It is a well known fact that plants flower during the dry season, and if a grand display of colour in the garden is expected during these seasons, planning and planting the flower border should be done beforehand. For the March-April dry season commonly called the Nuwara Eliya season, planting should commence from November of the previous year and end by January. For the August season, planting should commence in May, but very little can be done during this time on account of the strong winds which are experienced during June and July. However, weather-resistant, early-flowering annuals and perennials like Salvia, Browallia Cuphea, Marigold, Solidago, Michaelmas Daisies, Calendulas and Begonias may be planted in borders during this period. This planting programme applies to well established borders, but planting a newly constructed border should commence earlier as the newly planted perennials take some time to establish.

A plan of a mixed border suitable for a hill-country garden is given in Fig. 1. This plan can be modified to suit individual preferences. The separate species should be planted in clumps of about four or five of each kind. The distance between individual plants in a

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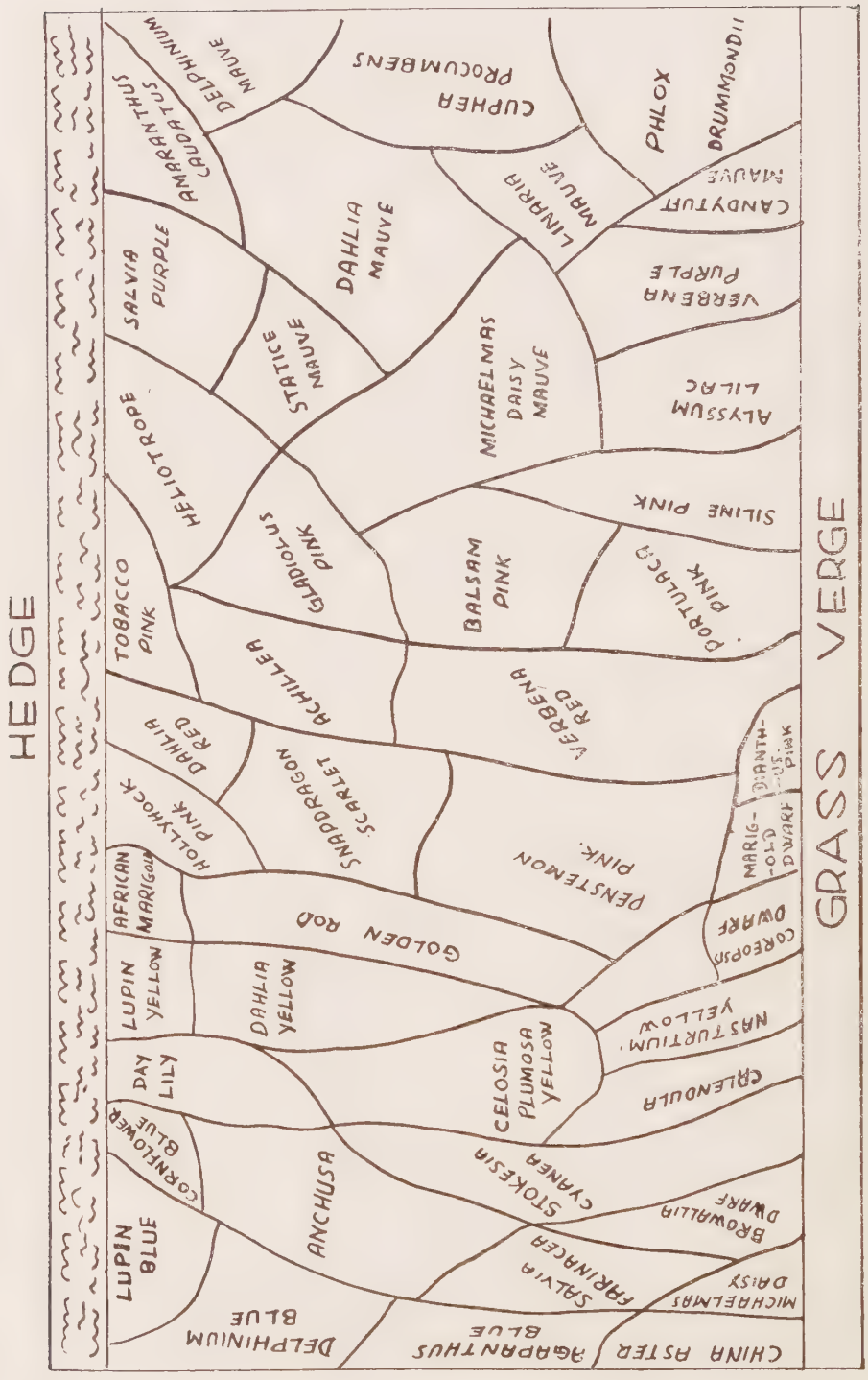

Fig. 1.—Plan of a mixed border.

clump should be in proportion to the heights of the plants. Overcrowding should be avoided but, planting should be uniform to eliminate bare patches. For the main Nuwara Eliya season in April, seeds of snapdragon, pansies, dianthus, hollyhock, phlox and other late flowering varieties should be sown from September onwards of the previous year. When the seedlings are hardy enough, they should be planted in the border in their appropriate places. All general planting should be over by January. In high elevation districts, like Nuwara Eliya, it will be necessary to cover the young plants in the night with cadjans to protect them from frost. The frost should be washed down by watering early in the morning.

BULBS IN THE MIXED BORDER

A WIDE range of bulbous plants are grown in hill districts, and as true perennials, bulbs should be given a place in the flower border. Most of the bulbs like Hemerocallis (Day lily), Crinum and Agapanthus produce flowers during the off season. Thus during the monsoons, when it is not possible to cultivate annuals, the bulbs will provide colour.

CARE AND MAINTENANCE OF THE BORDER

WHEN the plants are well established in the border, regular tillage in the form of forking around the plants is essential. It is also beneficial to apply a dressing of artificial manure. The following mixture has been found very satisfactory at the Botanic Gardens, Hakgala—

2 parts sulphate of ammonia,
2 parts superphosphate,
1 part sulphate of potash.

This mixture should be applied at the rate of about 3 oz. per sq. yd. After application, the soil should be lightly forked and heavily watered. Occasional weeding, removal of dead plants, staking of tall plants and filling of vacancies should be done. During dry spells, watering should be done once a day.

PESTS AND DISEASES IN THE FLOWER BORDER

THE common pests in up country gardens are caterpillars, beetle larvae, cut-worms, slugs and snails, greenfly and other aphids, capsid bugs and red spider, and other mites. Caterpillars eat leaves, leaf buds and flowers, and are best destroyed by a spray consisting of :

Lead arsenate	..	.. 1 oz.
Water	..	.. 1 gallon.

Caterpillars on flowers and flower buds should be removed by hand picking as spraying an insecticide may damage the flowers. Beetle larvae and cut worms are destroyed by using insecticides like aldrin or Intox 8 or any other insecticide suitable for soil pests. Slugs and snails are very troublesome pests in mixed borders. They usually attack seedlings in the night. They are destroyed by using a suitable slug bait available in the market. Greenfly and other aphids are destroyed by using contact poisons like D.D.T., Gammexane, Basudin 60, Gammalin and Nicotine sulphate. Mealy bugs and capsid bugs are difficult to destroy, and special insecticides have to be used against them. Red spider, which is a troublesome pest during dry weather, is destroyed by using an insecticide like Fernasul.

In contrast to insect pests, fungus diseases of flowers are rare. Damping off is very common in the hill country during wet weather. The fungus attacks seedlings at ground level, and the plants fall over at that point. Overcrowding and overwatering should be avoided. Blight, leafspot and stem rot are often troublesome. These diseases are controlled with copper fungicides. Bacterial wilt occurs frequently, but there is no known cure for this disease. Affected plants should be removed and destroyed without delay.

SELECTIONS OF PLANTS FOR BORDERS IN HILL COUNTRY GARDENS

Plants for the blue section of the mixed border:

Annuals :

Botanical Name	*Common Name*	*Height in inches*
Ageratum mexicanum	Ageratum	6–12
Anchusa italica	Anchusa	12–18
Browallia (dwarf)	Browallia	6– 9
Browallia (tall)	do.	12–15
Callistephus chinensis	China Aster	9–18
Centaurea cyanus	Cornflower	36–48
Delphinium Spp.	Larkspur	18–24
Lupinus Spp.	Lupins	24–36
Nigella damascena	Love-in-a-Mist	12–18

Perennials :

Agapanthus umbellatus	Agapanthus	24–36
Aquilegia vulgaris	Columbine	9–12
Aster amellus	Michaelmas Daisy	9–15
Campanula rapunculoides	Campanula	9–12
Delphinium Spp.	Larkspur	24–36
Limonium sinuatum	Statice	12–18
Lupinus Spp.	Lupins	24–48
Salvia farinacea	Saliva	12–15
Stokesia cyanea	Stoke's Aster	6–9
Vinca minor	Periwinkle	6–9
Viola cornuta	Pansy	6–9

Plant for the red section of the mixed border:

Annuals:

Botanical Name	*Common Name*	*Height in inches*
Amaranthus caudatus	Love-lies-bleeding	18–24
Clarkia elegans	Clarikia	18–24
Cosmos bipinnatus	Mexican Aster	36–72
Cuphea procumbens	Cuphea	9–12
Dianthus chinensis	Pinks	9–12
Linaria Spp.	Linaria	24–36
Malcomia maritima	Virginian Stock	6–9
Nicotiana alata grandiflora	Tobacco plant	18–36
Papaver Spp.	Poppy	18–24
Petunia hybrida	Petunia	9–18
Phlox drummondii	Phlox	9–12
Portulaca grandiflora	Sun Flower	4–6
Schizanthus hybridus grandiflorus	Butterfly Flower	18–32
Silene picta	Silence	12–15
Tropaeolum majus	Nasturtium	9–12

Perennials:

Achillea Spp.	Milfoil	18–25
Agrostemma coronaria	Campion	12–14
Althaea rosea	Hollyhock	72–128
Anemone joponica	Windflower	12–10
Antirrhinum majus	Snapdragon	12–18
Aster amellus	Michaelmas Daisy	9–18
Bellis perennis	Daisy	4–5
Dahlia Spp.	Dahlia	18–16
Dianthus barbatus	Sweet William	9–16
Gladiolus Spp.	Gladioli	36–45
Impatiens sultani	Balsam	9–15
Mesembryanthemun Spp.	Fig Marigold	6–9
Penstemon Spp.	Beard Tongue	12–24
Salvia coccinea	Salvia	12–24
Salvia splendens	Scarlet Sage	12–38
Verbena Spp.	Vervain	6–6

Plant for the yellow section of the mixed border:

Annuals:

Calendula officinalis	Calendula	9–12
Celosia plumosa	Celosia	15–24
Eschscholtzia californica	Californian Poppy	12–18
Helianthus annuus	Sunflower	48–60
Linaria Spp.	Linaria	24–36
Lupinus Spp.	Lupins	24–48
Tagetes erecta	African Marigold	36–48
Tagetas patula	French Marigold	9–24

Perennials:

Antirrhinum majus	Snapdragon	12–18
Coreopsis grandiflora	Coreopsis	9–12
Coreopsis dwarf	do.	4–6
Dahlia Spp.	Dahlia	18–60
Gladiolus Spp.	Gladioli	36–48
Hemerocallis Spp.	Day Lily	24–36
Limonium sinuatum	Statice	12–18
Linum trigynum	Linum	36–48
Solidago Spp.	Golden Rod	12–18
Streptosolen jamesoni	Fire-bush	48–60
Tithonia diversifolia	Wild Sunflower	48–120
Tropaeolum majus	Nasturtium	9–12
Viola cornuta	Pansy	6–9

Plant for the purple section of the mixed border :

Annuals :

Botanical Name	*Common Name*	*Height in inches*
Alyssum maritimum Lilac Queen	Sweet Alyssum	4–6
Callistephus chinensis	China Aster	9–18
Clarkia elegans	Clarkia	18–24
Delphinium Spp.	Larkspur	18–24
Iberis umbellata	Candytuft	6–12
Linaria Spp.	Linaria	24–36
Lupinus Spp.	Lupins	24–48
Malcomia maritima	Virginian Stock	6–9
Petunia hybrida	Petunia	9–18
Phlox drummondii	Phlox	9–12
Schizanthus hybridus	Butterfly Flower	18–32
Verbena Spp.	Vervain	6–9

Perennials :

Althaea rosea	Hollyhock	72–120
Antirrhinum majus	Snapdragon	12–18
Aster amellus	Michaelmas Daisy	9–15
Brunfelsia uniflora	Brunfelsia	4–5
Delphinium Spp.	Larkspur	24–36
Heliotropium peruvianum	Heliotrope, Cherry-Pie	3–4
Hibiscus syriacus	Rose Mallow	4–6
Limonium sinuatum	Statice	12–18
Phlox drummondii	Phlox	9–12
Prunella grandiflora	Self Heal	6–9
Salvia farinacea	Salvia	12–18
Scutellaria violacea	Skullcap	9–12
Verbens Spp.	Vervain	6–9

White flowers for the mixed border :

Annuals :

Alyssum maritimum	Sweet Alyssum	4–6
Ammi majus	Lady's Lace	36–60
Iberis umbellata	Candyctuft	6–12
Malcomia maritima	Virginian Stock	6–9
Silene picta	Silene	12–15

Perennials :

Aster amellus	Michaelmas Daisy	9–15
Bellis perennis	Daisy	4–6
Chrysanthemum leucanthemum	Ox-Eye Daisy	18–36
Crinum moorei, alba	Monsoon Lily	24–48
Dahlia Spp.	Dahlia	18–60
Gladiolus Spp.	Gladioli	36–48
Hydrangea hortensis	Hydrangea	24–48
Watsonia densiflora	Watsonia	18–36

A NOTE ON STORAGE TESTS ON PADDY

By

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LIKE all other cereals, paddy is subject to deterioration on storage. The chief factor responsible for its deterioration is its moisture content. It is well known that a moisture content above 12 per cent is detrimental to the keeping quality of paddy. High moisture content encourages the development of insects and fungi. Excess moisture results in the grain being attacked by insects and also it soon becomes rancid and unfit for human consumption. It also loses its viability (germination properties).

An investigation was carried out to ascertain the changes in moisture content after harvesting, sun drying and storage over a period of 9 months, in view of the necessity to store seed paddy over this period for issue to cultivators and millers.

The paddy after harvesting and threshing, was thoroughly sun dried for 3 to 4 days before storage in gunnies and bins. Eight varieties of paddy were stored in this manner in store houses and protected from damp and rain, at Batalagoda, Maha Illuppallama and Polonnaruwa, Research Stations. The moisture contents were determined soon after harvesting and threshing and then after sun drying for 3 to 4 days. Thereafter, the moisture contents were determined every month, after storage in gunnies and bins.

The results of these investigations are shown in Table I and the trends of increase in moisture are shown in Graphs "A" and "B".

From the above results it was found that the average moisture content after harvesting and threshing was 16.0 per cent. After sun drying for 3 to 4 days the average moisture content was 7.3 per cent. The average moisture content increased to 10.0 per cent and 9.1 per cent when the paddy was stored in gunnies and bins respectively for 9 months.

It can be concluded from the above results that provided the paddy is thoroughly sun dried to bring the moisture content to below 8 per

cent, there is no risk of the moisture level going above 12 per cent after storage in gunnies and bins for as long as 9 months.

It was also found that paddy stored at a moisture level below 12 per cent in glass jars, did not develop any rancidity over a period of one year. Rancidity development was detected only after 2 years.

Gunnies and bins are commonly used in Ceylon for storing paddy. These methods of storage are satisfactory, provided the paddy is kept in well-built store houses, protected from rain and damp and sealed off effectively from the outside atmosphere. Under these methods of storage, paddy can be kept for easily one year without any deterioration, if proper steps are taken to prevent insect infestation and fungal attack.

Acknowledgements:

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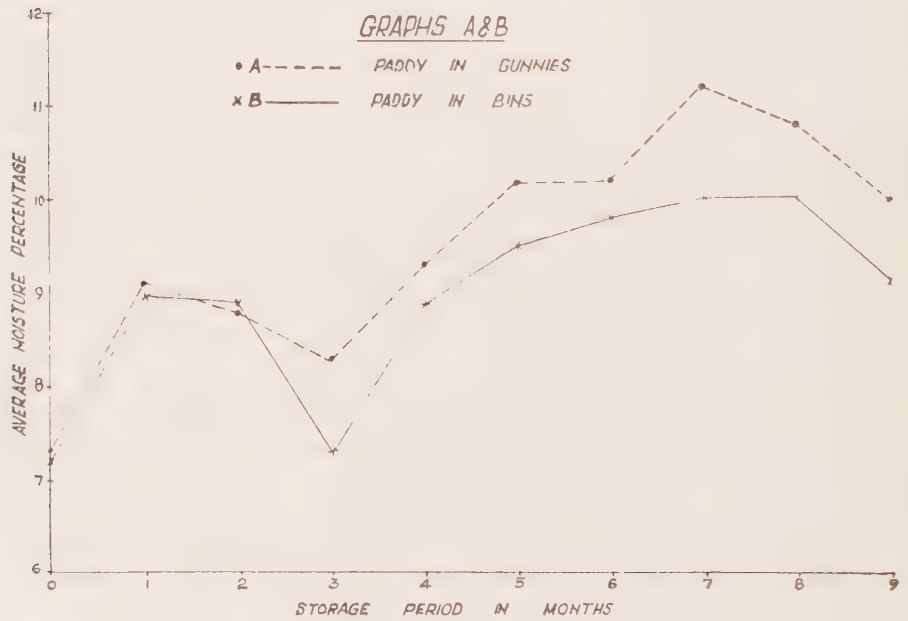

Trends of increase in moisture in stored paddy.

TABLE I

	Variety	%Moist. Harvest & threshing	%Moist. Sun Dried	%Moist. 1 month Storage Gun.	%Moist. 1 month Storage Bin.	%Moist. 2 months Storage Gun.	%Moist. 2 months Storage Bin.	%Moist. 3 months Storage Gun.	%Moist. 3 months Storage Bin.	%Moist. 4 months Storage Gun.	%Moist. 4 months Storage Bin.	%Moist. 5 months Storage Gun.	%Moist. 5 months Storage Bin.	%Moist. 6 months Storage Gun.	%Moist. 6 months Storage Bin.	%Moist. 7 months Storage Gun.	%Moist. 7 months Storage Bin.	%Moist. 8 months Storage Gun.	%Moist. 8 months Storage Bin.	%Moist. 9 months Storage Gun.	%Moist. 9 months Storage Bin.
Maha Batalagoda	Molagu																				
	Samba g18	22·6	5·1	6·5	6·8	8·8	9·0	9·0	9·2	9·5	8·7	10·2	9·2	12·3	10·9	12·7	9·5	10·6	10·0	9·5	8·6
	Ptb 16	16·4	6·3	7·5	—	8·5	—	8·7	8·8	10·2	8·4	10·3	9·0	11·0	12·8	10·6	10·1	10·9	9·6	10·1	9·0
	Mass M 24	16·2	7·6	8·8	7·2	7·9	8·0	7·9	7·8	10·7	9·5	10·1	10·9	12·9	12·2	10·6	10·4	11·2	10·4	10·4	9·6
	Siam 29	18·5	6·5	—	7·8	8·8	8·7	8·7	8·5	10·2	9·7	10·3	9·3	12·2	12·1	10·8	10·1	10·4	9·9	10·0	9·1
Maha Illuppallama	H M C 20	12·8	7·6	9·8	10·0	9·2	9·0	7·7	6·8	8·7	8·8	—	—	8·6	8·3	—	—	—	—	—	—
	V I 28061	14·8	7·6	9·8	10·5	9·1	9·1	7·8	6·5	8·6	8·7	—	—	9·2	8·7	—	—	—	—	—	—
	Murunga-kayan 302	—	7·6	9·5	10·2	9·3	9·2	7·7	6·0	8·7	8·8	—	—	8·4	7·5	—	—	—	—	—	—
	H S 276	13·5	7·4	10·1	9·5	8·9	9·0	7·3	5·7	8·6	8·8	—	—	8·5	7·8	—	—	—	—	—	—
	Mas M 24	13·6	7·4	9·6	9·7	9·1	9·0	8·0	6·4	8·7	8·9	—	—	9·1	7·7	—	—	—	—	—	—
Polonnaruwa	Ptb 16	15·3	9·6	10·1	9·1	—	—	10·1	—	9·5	—	—	9·2	—	—	—	—	—	—	—	—
Average % Moisture		16·0	7·3	9·1	9·0	8·8	8·9	8·3	7·3	9·3	8·9	10·2	9·5	10·2	9·8	11·2	10·0	10·8	10·0	10·0	9·1

BEEKEEPING FOR HONEY PRODUCTION

A Study of the Factors Involved

by

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THE Ceylon honey bee (*Apis indica*) is reared for the production of honey rather than for promoting the pollination of crops. Swarms are acquired either by capturing them from wild nesting sites, or by attracting stray swarms during the active swarming seasons to receptacles advantageously placed on trees in home gardens. While some part of the honey gathered in Ceylon is from colonies so reared, the greater portion is obtained by raiding the nesting sites of honey-bee colonies in jungles and forests, particularly in the North-Central, Eastern and Southern Provinces, and in Lower and Upper Uva, and by plundering combs of honey from the brood nests. These methods are to be deplored as they are destructive of bee life. In the process of collecting the honey combs, the brood combs from the brood nests are also damaged. The honey thus gathered in Ceylon finds its way mainly to the numerous ayurvedic dispensaries in the island.

During the period 1954-57, investigations were in progress on the behaviour of *Apis indica* colonies captured from jungles and maintained in standard bee boxes in different sites for the purpose of selecting suitable strains and evolving a simple, inexpensive and economic system of beekeeping suited to the varied floral and climatic conditions which Ceylon presents. The results of these investigations are described herein.

MATERIALS AND METHODS

The honey bee colonies used in the Kandy District were captured chiefly from nests in hollows of coconut palms and from husk heaps in the Kurunegala District, and maintained in bee boxes of the 'standard' type, the frames of which were provided with wax comb foundation. Colonies used in the Nuwara Eliya District were

A standard type hive on a wooden stand under the shade of a tree.

Hive type :
Left—standard type.
Centre—Newton type.
Right—Ceylon type.

captured from the hollows of jungle trees in Nuwara Eliya, and maintained in 'standard' bee boxes provided with a protective cover against cold and winds. The bee hives were placed on wooden stands and the colonies were fed on concentrated sugar syrup till brood rearing commenced. It appears desirable to preface the statement of the results of investigations with an account of the evolution of the 'standard' type of hive.

THE BEEHIVE TYPE

Since the introduction of the movable-frame hive into Ceylon about half a century ago, hives of diverse sizes and shapes have been in use. Messrs. A. P. Goonetillake and C. Crozier, among others, used the 10-frame hive. In this hive, which has come to be known as the Ceylon type, the brood box for breeding and rearing the young, and the super for the storage of honey are of the same size. The super frames possess a capacity of at least 10 lb. of honey. Experience showed that it was only in exceptionally good years that beekeepers obtained a full super of honey. The contraction and dwindling of the colony during the rainy season exposed the vacant combs to the attack of the wax moth. In this type of box, absconding was frequent, and the aftercare of colonies was difficult. For the reasons enumerated, the Ceylon hive did not find favour with beekeepers. Molegoda and Kannangara (1940) introduced a type of hive commonly used in South India, called the Newton hive—so named after the designer, a Jesuit priest. The virtue of this hive was that the brood box was small and compact with seven frames. The supers were half the size of the brood box. There were two supers per box and more were added as they became necessary. The box was designed to provide successive, small but quick crops of honey. Each super was estimated to yield 3 lb. of honey. The small size of brood box ensured the covering of all the combs in the brood nest. The colony was thus able to defend itself against the wax moth and other enemies. The Newton type permitted the after-care of honey bee colonies during rainy seasons and eliminated absconding. This box was quite popular with beekeepers owing to the ease with which quick crops of honey were obtained. Boxes of the Newton type persist in many areas even today. An unsatisfactory feature of the Newton type was that the brood box easily gets overcrowded, and the space available for nesting becomes restricted. This restriction of nesting space induces swarms to escape during the active breeding season. Butler, during his stay in Ceylon, in 1953, recommended a modification of the Ceylon hive, incorporating all the virtues of the Newton type, but restricting the brood box to six frames of the same size as those in the Ceylon

Comparative sizes of frames in the Hive Types.

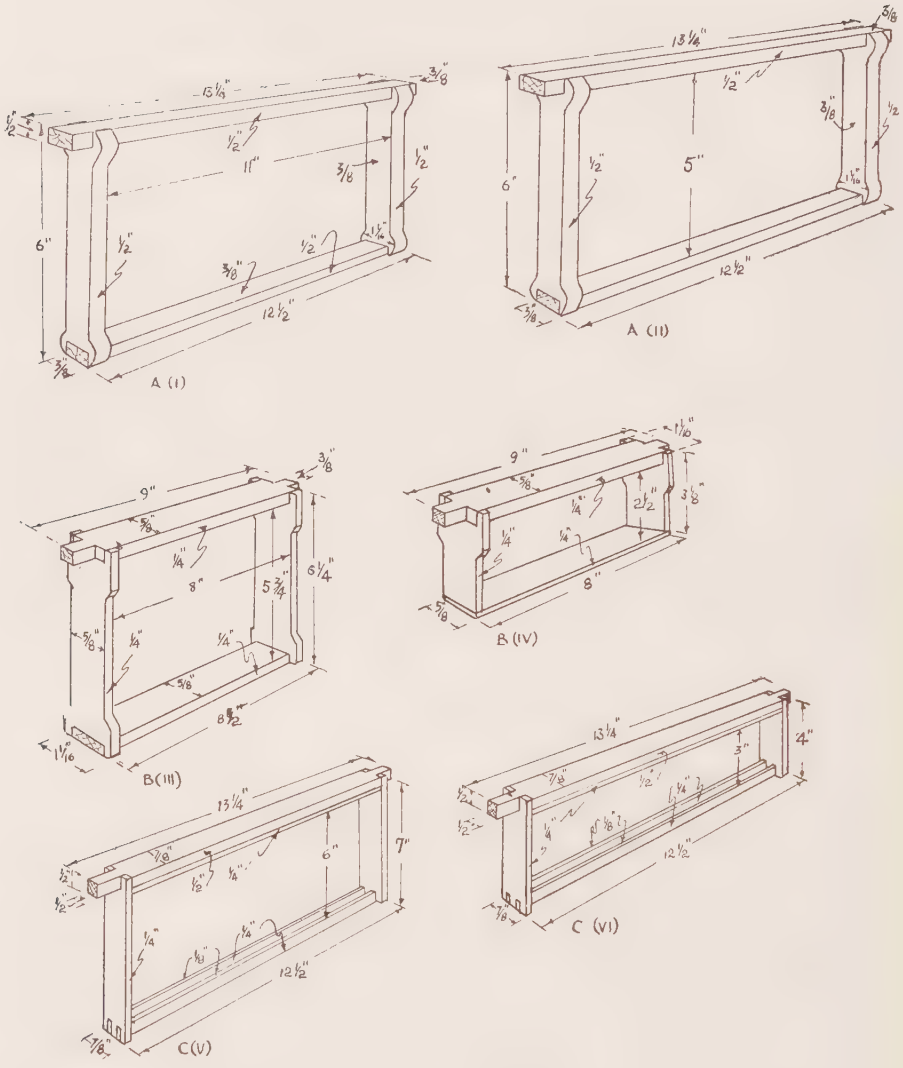


FIG. A : (i) The frames shows the size of a frame in brood box of Ceylon type.
FIG. A : (ii) The frames shows the size of a frame in super of Ceylon type hive.

FIG. B : (iii) Shows the size of a brood frame in a Newton type hive.
FIG. B : (iv) Shows the size of a super frame in a Newton type hive.

FIG. C : (v) Shows the size of a brood frame in a standard type hive.
FIG. C : (vi) Shows the size of a super frame in a standard type hive.

type ; the super was half the size of the brood box, and two supers were provided per box. The small brood box discouraged absconding of colonies after the honey flow season which was a common occurrence with the 10-frame Ceylon hive. The provision of small supers permitted quick storage of surplus honey for extraction without damage to combs. It was, however, found that the bees generally used the first super for the storage of pollen, sometimes even extending the brood area to the super frames. Dr. B. A. Baptist, in 1955, increased the depth of the brood combs by one inch to overcome this difficulty, and also to allow more brood space. Baptist also introduced, for the higher elevations, an outer cover to provide warmth and protection against wind. This box is now referred to as the 'standard' bee box.

SYSTEM OF MANAGEMENT

During the first year, monthly records were made of the development of brood and continued survival of colony in the site, incidence of swarming, and availability of surplus honey. In later years, examination was less frequent, and less thorough, but it was possible to ascertain the continued survival of the colony, the incidence of swarming as indicated by the presence of sealed " queen cells ", the departure of swarms of bees from the colony, and the brood content. Artificial feeding with sugar syrup was done during the first few months of its establishment till the brood filled half the brood box.

THE LOCATION OF COLONIES

The colonies were established in 1954-55 in 'standard' boxes and placed on wooden stands in sites mentioned below. Observations were made over the period 1954-57 on the performance of the individual colonies with special reference to the yield of surplus honey.

Locations of the Honey bee colonies :

Area	
Kandy	(1) Experimental Station, Peradeniya—Rubber, Coconut, Tea and Orchard areas of the Experimental Station.
	(2) Royal Botanical Gardens, Peradeniya.
	(3) Kings Pavilion, Kandy.
	(4) Mahakanda Estate.
	(5) Kundasale Estate.
	(6) The University, Peradeniya.
	(7) Home Gardens.

Nuwara Eliya
- (8) Queens Cottage, Nuwara Eliya.
- (9) The Lodge, Nuwara Eliya.
- (10) Botanic Gardens, Hakgala.

The Experiment Station, Peradeniya :

This area comprised rubber, coconut, tea and orchard. A number of colonies was placed in the area in groups of four at various points where usually one major crop predominated.

Royal Botanic Gardens, Peradeniya :

There was wide diversity in the flora.

King's Pavilion, Kandy :

The site was adjacent to a small forest reserve which provided the predominant floral type.

Kundasale Estate :

The colonies were located in sites where the vegetables and fruit trees were the dominating floral types. Colonies were also located in the highland cropping area where there was an avenue of *Peltophorum* sp.

The University, Peradeniya :

There was no dominant flora in this area.

Home Gardens :

There were no predominant species.

Nuwara Eliya :

The flora of this area consisted largely of fruit trees, such as pears, plums, peaches, and the forest species.

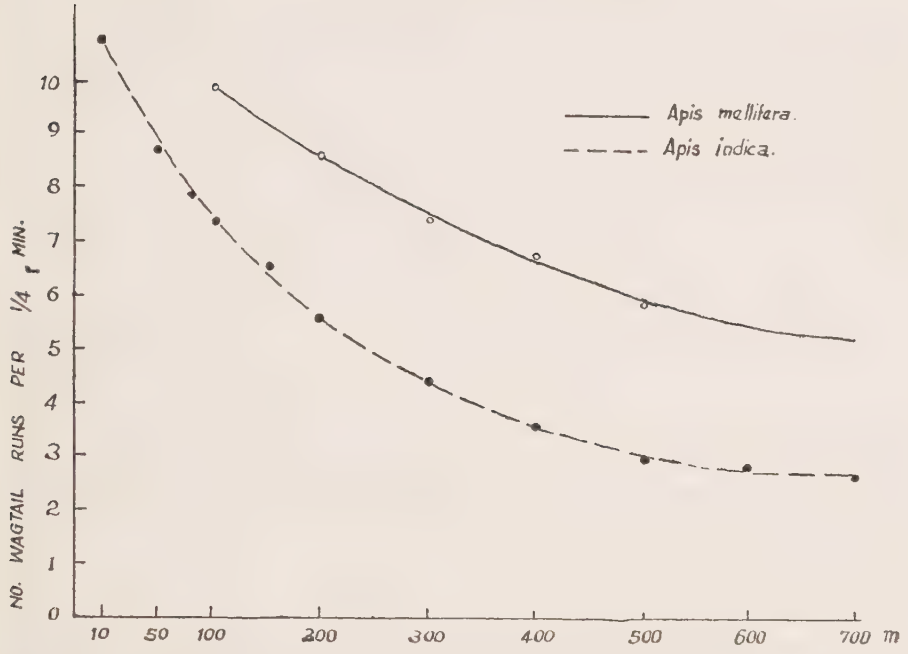
Mahakanda Estate :

This area comprised a mixed flora with abandoned rubber predominating.

RESULTS OF OBSERVATIONS

1. Brood development in Honey bee colonies :

IN contrast to temperate countries, brood development in honey-bee colonies in Ceylon extends throughout the year (Table 1). Significant increases in brood development occurs during the honey flow season,



A comparison between the maximum foraging range of *Apis indica* in relation to *Apis mellifera*. (After von Frisch, 1951, and Lindauer, 1956.)

The distances are indicated by the number of wagtail runs per quarter minute each forager bee does on return to its respective colony.

when there is a profusion of flowers, and dry and sunny weather suitable for flying. There was significant variation in the amount of brood in individual colonies captured from the jungles in the same site at any given time of the year, the amount of brood depending largely on the fecundity of the queen. A striking example of this variation in the potentiality for the development of brood was demonstrated at Kundasale. On December 30, 1954, four colonies captured in coconut areas near Batalagoda, and established in 'standard' boxes, were moved to four locations on Kundasale Estate. The colonies were fed regularly with concentrated sugar syrup for two months. Examination at the end of February, 1955, reveal that the brood level was restricted to two frames in three of the colonies, whilst in the fourth the brood level had risen to four frames. In March-April, 1955, every one of the four colonies was allowed to form a new queen by the removal of the old one. All four queens emerged and were subsequently mated and they commenced their egg lay towards the end of April. In August, 1955, the brood level in three colonies did not exceed two frames, whilst the fourth colony had five frames of brood in spite of the fact that all the colonies received the same feeding and attention. In

4——J. N. R 11538 (8/60)

August, 1955, queens were raised artificially from material obtained from the colony with the greatest amount of brood. All four colonies were successfully "re-queened", from the material during dry weather of August-September, 1955. In November and December, 1955, the brood level in all four colonies had increased to five frames of brood. The progeny of these colonies continued to rear brood in large quantities during the period 1956-58, and yielded 15-21 lb. of extracted honey per colony per year. An examination of the history sheets of the individual colonies in the various locations revealed that colonies selectively requeened had a higher content of brood than the others. Table I, shows average of brood found in honey-bee colonies maintained at various sites for three years. There was no significant difference in brood content in the different locations. However, there were indications that the Kundasale brood content was somewhat different to that in Peradeniya ; the difference just failed to reach significance. This was due to the fact that four out of nine colonies at Kundasale were "re-queened" from material obtained from the best colony in existence at Kundasale.

2. Absconding :

The chief problem of beekeepers in Ceylon is the absconding of honey bee colonies from boxes. Table 2 indicates the incidence of absconding of colonies in boxes. The total disappearance of colonies, especially during the onset of the rainy season when they leave their nesting site is a common phenomenon. Absconding must not be confused with reproductive swarming which is discussed elsewhere. Absconding was very common at the various sites in the Kandy District, during the heavy rains of May, June, July, October and November. Colonies at the initial stages of development had to be regularly fed with sugar syrup during periods of heavy rain to discourage absconding. In the Nuwara Eliya District, surplus honey was found in the supers at all times of the year, once the colony was established in the site as indicated in Table 3. There was thus no need for artificial feeding in these localities and there was no absconding. The chief factors responsible for absconding were :—(*a*) insufficiency of food in the brood nest to tide over unfavourable periods ; (*b*) invasion by ants and wasps ; (*c*) frequent disturbances ; (*d*) invasion of the wax moth ; (*e*) desertion of new site ; (*f*) incorrect location of colonies ; (*g*) persistent swarming.

3. Invasion by Ants and Wasps :

Oecophylla spp. of ants build their nest on the foliage of trees under which honey-bee colonies are sited, and climb into the hive through the wide entrance. The honey-bee colony is unable to defend itself

effectively against these ferocious ants, and absconds. In the Kandy District absconding was overcome by the destruction of *Oecophylla* nests, by the application of an effective repellant (e.g., Aldrin dust) at the base of the wooden stand, and by painting the hive stand with waste oil. The entrance to the hive was also contracted to 3 in. to enable the bees to deal more effectively with intruding ants. Wasps (*Vespa* spp.) cause complete destruction of colonies by repeated removal of worker bees as they leave or return to the hive. Total destruction of colonies was caused at Bandarawela by the activities of the wasps. The most effective way of combating wasps was the burning of the wasp nest after sunset by holding a '*chulu*' light to the bottom of the nest.

4. Frequent disturbances:

These can be very detrimental to a colony that is building up and is not properly established in the new site, and may cause the bees to abandon the hive.

5. Invasion by wax moth (Galeria melonella) :

Whenever empty combs are left uncovered by bees, the female wax moth is attracted to lay eggs on them. Larvae that hatch from these eggs eat the combs and spin a cocoon reducing the comb to a powdery mass. A small colony unable to cover the full complement of combs, and in too a weak condition to defend itself against the invasion by the wax moth, may abscond. On the other hand, if the colony is very strong and all the combs are covered with bees, the wax moth can do little damage, and the bees will not abscond.

6. Desertion from new site:

Colonies captured from the jungle and introduced to 'standard' bee boxes with an entrance guard or excluder sheet to trap the 'queen' always tend to abscond in the new site. The incidence has been as high as 50 percent. Once the colony has settled down to normal brood rearing the tendency to abscond declines. Regular feeding of colonies with sugar syrup helped the rapid build-up of the brood nest and discouraged the tendency to abscond.

7. Faulty location of colonies:

Colonies of *Apis indica,* in nature, are always found in sheltered positions away from direct sun and rain. Honey bee colonies in boxes must be located under overhanging shade and on a stand few feet

away from the ground to overcome invasion by ants. Insolation for long periods causes excessive heating of hives and induce large numbers of bees to come out and cool themselves. This results in a slackening of foraging and brood rearing activities, followed by an abandoning of the hive.

8. Persistent swarming:

Repeated and successive removal of swarms in a season from a single colony reduces its capacity to maintain itself in an area in the absence of a honey flow and there is a strong tendency to abscond immediately the honey flow season is over, unless artificial feeding with sugar syrup is done.

9. Swarming:

In *Apis indica,* swarming occurs every year. Swarming means the departure of a portion of a colony with the old queen to another nesting colony, after having made provision in the original colony for the formation of another queen. Swarming was indicated by the presence of sealed 'queen cells' and a great reduction in the number of bees. Since the wings of the queen were clipped in the colonies under observation some colonies 'requeened' themselves under the swarming impulse without the loss of a swarm. It was, however, noted that the incidence of swarming in Nuwara Eliya District was less than that of Kandy District. Frequency of swarming varies widely between colonies. Some colonies send out a number of swarms in a season and are reduced to a weak and exhausted condition. Other colonies send out a single swarm in a season, and continue to store relatively large reserves of honey.

10. Foraging range:

Lindauer demonstrated that the foraging of *Apis indica* is 1/10 that of *Apis mellifera,* the honey bee of the temperate regions (Fig. 2). This was demonstrated by the observations of the "dance tempo" of marked forager bees in a glass-walled bee box after feeding at an artificial feeding source. The "dance tempo" is worked out by the number of wagtail runs per quarter minute each worker does on return to the hive, by a form of movement of the body called "bee dances". The dances are of two kinds: "round" and "wagtail" dances.

At Peradeniya it was found that *Apis indica* could not be enticed beyond 750 metres. The last dance tempo was recorded at 700 metres. This clearly indicates that the active foraging range of *Apis indica* is

very limited and the storage of large reserves of stores is tied up with the availability of forage in close proximity to the colony. This discovery indicates that honey bee colonies should be widely diffused in small units.

11. Honey yields :

Records for individual colonies are summarised in Table 3. The longest observation period in any site was six years. Colonies with such histories exist at Peradeniya, Kundasale, and Nuwara Eliya. The lowest individual yield from colony in a year was 2 lb. The highest yield of a colony for a single year of extracted honey was 35 lb. at Hakgala. It will be seen that specific floral conditions within foraging range of honey bees constitutes "good" and "poor" areas for bee keeping. Their average yields for various areas were :

Kundasale—6 lb.
Kandy—7½ lb.
Hill country—20 lb.

There was no significant difference in yield between Kundasale and Kandy. There was, however, a highly significant difference in yield between the hill country and Kandy. Table 3 clearly indicates the highly variable nature of the yield of honey in the Kandy area itself. The yield ranges from as low as 3 lb. to as high as 17 lb. Proximity to good forage is the chief factor influencing yield.

DISCUSSION

Productivity of bee keeping depends on (*a*) the provision of a satisfactory bee box with optimum conditions for brood development and honey storage, (*b*) a system of management that eliminates absconding in colonies of honey bee, (*c*) nature of the flora available within the foraging range of the honey bees, and (*d*) the quality of the local strain of bee used.

Table 3 indicates that within a district, such as in Kandy, colonies situated in good floral conditions will yield surplus extractable honey ranging from 10 to 17 lb. per colony per year ; while in poor locations in the same district, individual colonies yielded a surplus ranging from 3 lb. to 7 lb. per year. The swarming tendencies of particular strains were reflected in the variations shown in the records of individual honey bee colonies in the same site. The superior performance of colonies in the tea area of Experiment Station, Peradeniya, as opposed to other sites of the Station, was due to greater proximity to forage. Colonies that did not abscond continued to yield honey in

successive years and survived in a particular site for as long as 6 years. Variation in honey bee colonies in regard to the incidence of swarming and fecundity of queens can form the basis of selection.

The strain of bee found in Nuwara Eliya and Bandarawela Districts is darker in colour and larger in size than the bees found elsewhere in Ceylon. The average yields of 20 lb. per colony of unselected *indica* bees obtained in these areas compare favourably with the yield of 70 lb. from selected *mellifera* bees of the West, after corrections are made for difference in body size of the two species and the large consumption of winter-stores by the latter. *Apis indica* is two thirds the size of *Apis mellifera*. *Apis mellifera* requires nearly 40 lb. of stores during winter with no corresponding gain to the colony. *Apis indica* has no such need in the tropics. *Apis mellifera* is subject to numerous diseases which have so far not been recorded on *Apis indica* in Ceylon. The success of bee keeping in villages in this country depends on the cheap supply of selected *indica* strains established in 'standard' bee boxes.

The economic returns possible from bee keeping are indicated below :—

Area	*Estimated cost of establishing a four-hive unit with selected* indica *strains*	*Estimated gross return per annum from a four-hive unit*	*Estimated net return per annum (Establishment charges deductable over a four-year period* Rs. c.
Kandy District ..	Rs. 50 ..	12 lb. honey per hive valued at Rs. 3 per lb. Rs. 144	131 50
Nuwara Eliya District and forest reserves	Rs. 60 ..	20 lb. honey per hive valued at Rs. 3 per lb. Rs. 240	225 0
Home gardens ..	Rs. 50 ..	10 lb. honey per hive valued at Rs. 3 per lb. Rs. 120	77 50
Coconut estates ..	Rs. 50 ..	10 lb. honey per hive valued at Rs. 3 per lb. Rs. 120	77 50
Tea plantations and forest reserves	Rs. 50 to Rs. 60..	15 lb. honey per hive valued at Rs. 3 per lb. Rs. 180	160 0

The requirements in men, money and material for a bee project of this nature are small. Not only, does the keeping of bees provide the peasant a supplementary income of considerable size, but also supplies him an article of food of great nutritive value.

ACKNOWLEDGEMENT

I am deeply grateful to Dr. B. A. Baptist, University of Ceylon, Peradeniya, for valuable direction and assistance. My thanks are also due to Mr. H. M. A. Chandraratna for the photographs.

TABLE 1

Averages of Combs of Brood in *Apis indica* colonies 1954-57

Place	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Average per month*	*No. of colonies*
Kundasale Estate	5·0	4·7	4·3	4·0	3·9	4·3	5·0	4·6	4·7	3·0	3·6	2·6	4·05	9
Mahakanda Estate	4·4	6·0	2·5	3·3	3·5	4·5	3·6	2·7	3·4	3·3	4·2	5·4	3·9	4
Kings' Pavilion, Kandy	5·0	4·5	4·0	4·1	3·5	2·0	2·0	2·0	3·0	4·0	4·5	3·0	3·5	4
Rubber area, Experiment Station, Peradeniya	3·8	4·7	4·0	3·5	5·5	2·5	3·2	4·3	3·8	3·0	3·0	4·0	3·7	4
Kapok and Tea areas, Experiment Station, Peradeniya	4·5	4·0	4·5	3·7	4·0	5·0	2·0	3·2	4·0	3·5	4·0	4·0	4·03	4
Coconut area, Experiment Station, Peradeniya	3·7	4·5	3·7	5·5	4·3	4·0	3·7	4·2	3·0	3·0	4·0	4·7	4·02	3
Royal Botanical Gardens, Peradeniya	4·5	3·5	3·0	7·5	4·0	2·8	3·5	3·5	4·0	2·0	2·7	2·7	3·59	4
Home Gardens, Peradeniya	4·0	3·0	5·0	4·0	4·0	5·0	3·0	4·0	3·0	3·0	4·0	3·0	3·75	2
The Lodge, Nuwara Eliya	3·0	3·0	4·0	4·0	3·7	4·0	4·0	3·0	3·5	3·0	4·0	4·0	3·6	2
Queens Cottage, Nuwara Eliya	3·0	3·0	3·3	4·3	3·5	3·0	5·0	3·0	3·7	3·0	2·5	2·0	3·25	3
Botanic Gardens, Hakgala	2·0	4·0	4·0	4·0	4·0	4·0	3·5	4·0	4·0	4·0	4·0	4·0	3·79	2

(Standard Error : $\pm$ 0·25).

TABLE 2

Incidence of Absconding in colonies of *Apis indica*

	No. of colonies at time of observation 1954	*No. absconded in 1955*	*No. absconded in 1956*	*No. absconded in 1957*	*Survival for 3 year period(%)*
Orchard Area, Experiment Station, Peradeniya	12	5	1	0	50
Tea area, Experiment Station, Peradeniya	4	2	—	—	50
Coconut area, Experiment Station, Peradeniya	4	1	1	—	50
Rubber area, Experiment Station, Peradeniya	4	3	1	—	0
Royal Botanical Gardens, Peradeniya	4	2	1	—	25
Home Gardens	3	1	0	0	60
Mahakanda Estate ..	4	0	1	1	50
Kundasale Estate ..	4	—	—	—	100
Nuwara Eliya	6	—	—	—	100
University premises ..	3	1	—	—	66

TABLE 3

Averages of honey combs found in frames of supers in *Apis indica* colonies captured from the jungles and maintained in standard boxes at different location from 1954-1957

Place	*Jan.*	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*No. of colonies*	*Yield of honey per colony per year*	
														No. of combs	*Weight of honey in lb.**
Kundasale Estate	0·33	*1·55*	*2·33*	0·00	0·80	0·00	*1·27*	*3·42*	3·17	0·43	1·07	0·00	9	11·74	6
Mahakanda Estate	*1·55*	*3·67*	*2·75*	*4·55*	0·67	0·67	1·87	0·45	*1·20*	0·00	0·78	1·00	4	13·72	7
Kings Pavilion	*0·75*	*3·00*	*1·50*	0·00	0·00	0·00	0·67	0·00	0·00	2·00	0·00	0·72	4	5·25	3
Rubber area, Experiment Station, Peradeniya	*2·22*	*1·82*	*1·75*	*0·80*	*2·50*	0·00	0·22	0·25	0·37	0·00	0·00	0·00	4	9·09	4·5
Tea and Kapok area, Experiment Station, Peradeniya	*2·60*	*5·60*	*6·40*	*5·25*	*8·00*	*2·00*	*3·00*	0·00	0·60	0·50	0·00	1·67	4	32·85	17
Coconut area, Experiment Station, Peradeniya	*2·86*	*2·57*	*2·28*	*3·00*	*2·17*	*1·33*	0·00	*2·71*	0·31	0·00	0·37	2·00	3	18·92	10
Royal Botanical Gardens, Peradeniya	*2·17*	*4·17*	*2·40*	0·00	0·00	0·00	0·17	0·33	0·17	0·33	0·00	0·00	4	8·74	4·5
Home Gardens, Kandy	*3·00*	0·00	*2·67*	*6·00*	0·50	0·00	0·00	*3·00*	0·00	0·00	0·00	0·00	2	12·81	4·5
Home Gardens, Peradeniya	2·00	0·83	1·71	2·28	2·57	0·00	1·20	1·20	1·20	0·00	0·00	0·00	1		
Nuwara Eliya and Hakgala	1·63	4·05	2·11	4·58	1·56	1·12	3·07	1·07	0·33	0·00	3·53	0·40	6	20·53	20

Standard Error : ± 5·8 lb.

(*N.B.*—Only in the instance of italic figures were honey combs removed for extraction.)

*Except in the Nuwara Eliya District, where the comb yield was one lb. of honey, the conversion factor was ½ lb. per comb.

PARASITIC INFESTATIONS OF ANIMALS

By

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IT is probably true to say that one of the greatest interferences with progress in improvement in animal production throughout the world as a whole, so far as animal health is concerned, centres round parasitic infestations. Parasites of one type or another are the cause of disease in animals in every country : the damage they do and the losses they incur depends very much upon conditions of animal husbandry and the application of measures for control based upon the knowledge of the habits and life histories of the different parasites and on the use of agents at appropriate times to prevent infestations and to destroy the parasites in the animal body ; the information now available has been the result of patient research work in different branches of sceince, including veterinary science.

It is impossible to assess the losses from parasitic infestations throughout the world or even in a single country with any degree of exactitude. Losses from deaths of parasitised animals may be ascertained but, in some parasitic infestations, much greater losses may occur from retarded development of the infested animals and from waste of foodstuffs in keeping the animals alive instead of their utilization for normal or increased production. The time spent by animal owners and attendants in caring for and treating infested animals and the cost of medicaments have also to be taken into account and we must not forget that animals play an important part in the transmission of some parasites, during some stage of their life history, to human beings. All these add up to a vast economic loss to countries and to individual animal owners.

In articles such as this, it is possible only to make brief reference to some of the important diseases caused by parasites, as illustrations of this complex subject and of the present state of knowledge.

Although some types of parasites exist and infest animals in all parts of the world, others are strictly confined to certain regions : climatic conditions have an important bearing on the life of some

parasites and on the occurrence of vectors and the intermediate hosts required, for completion of the life cycles of some of the important parasites of animals.

Many varieties of worms infest animals and under certain conditions cause serious damage and losses in herds and flocks. With many, a state of tolerance on the part of infested animals may exist, whereby considerable numbers of worms may be harboured without any clinical evidence of disease. In some cases, infestations of the alimentary tract of young animals may be quite severe, but as the animals nature, tolerance develops and the worms, although still present and although re-infestation continues, do not appear to interfere to any marked extent with the adult animals' health.

In all species of domestic animals, the alimentary canal is the location of some types of round worms : cattle, sheep, goats, pigs, horses and popultry harbour them. Some are almost exclusively confined to the stomach, some to the intestine, even to special parts of the intestine, while others overflow into several different regions of the tract. Generally speaking, the species of worms infesting the alimentary tract are specific for the type of animal : although the same species may occur in, for example, the stomach of cattle and sheep, there appear to be strain differences as shown by difficulty in cross-transmission.

All worms found in the alimentary tract are not similarly parasitic and disease producers : in this respect, the general finding is that the smaller the worm, the more damage it is likely to cause. Again, the different species of the worms have different life histories and different treatments and control measures are required. Hence, it is necessary to identify the species of worm : this can be done only in the laboratory by experts in the subject who examine the worms and their eggs.

Life histories or life cycles of many of the worms, parasitic in the alimentary tract, have a considerable resemblance to each other. The females lay eggs which are passed out in the faeces and hatch out into larvae. The time taken to hatch depends upon the atmospheric and other conditions and may be only a few days. Again, the time taken for development of the larvae into the infective stage varies with the species and conditions. Eventually, the larvae in the infective stage are picked up by the susceptible animals and ingested into the alimentary tract, where they find their way to their selective location. In some species, the larvae penetrate into the walls of the stomach or intestine and remain there during their further development, emerging as sexually-mature adults when egg-laying takes place. The times

occupied in the different stages of development have been studied for many species. In some, the eggs actually hatch in the intestine. Many of the parasitic worms are blood suckers ; others, especially in the larval stages, cause damage to the lining membranes of the alimentary canal by irritation. It is usually only when large numbers of worms and larvae are present that actual parasitic disease is set up. Some species of worms infesting the alimentary tract have complicated life cycles. One, infesting the pig, for example, requires an intermediate host, the coprophagous beetle. In one of the large worms in the pig, the eggs hatch in the intestine and the resulting larvae find their way to the liver where they undergo further development and are then carried to the lungs where they enter into the alveolar spaces through the capillary blood vessels. The adult worms may do some damage by blocking the intestine and even causing its rupture ; they may also block the bile ducts. The larvae in the liver are the cause of " white spotted liver " ; the condition in pigs known as " thumps " is due to the presence of these larvae in the alveolar spaces of the lungs. In the horse, one of the large worms infesting the large intestine is of much interest. Following ingestion, the larvae migrate into branches of the mesenteric artories and cause aneurisms. Thrombi are produced and, because of their interference with the flow of blood to the intestine, colic ensues. From the thrombi, emboli may be released and may travel in the blood stream, eventually blocking some small blood vessels, the damage caused depending upon the organ or tissue in which the blockage occurs.

Although most of the infestations with worms of the alimentary tract take place through ingestion of the eggs or the larvae of the respective worms, some infestation may also occur through the skin.

Tapeworms also infest the alimentary tract. It is doubtful if many of them do extensive damage or cause actual disease. To some extent they must, of course, use up some of the available digested food in the intestine which might, otherwise, be utilized by the host animal. All tapeworms have a complicated life history in which intermediate hosts are necessary. The intermediate hosts of some are, as yet, unknown ; others are well established, e.g., free-living orbatid mites for one of the tapeworms of cattle. Tapeworms infestations in domestic animals and man, are, however, often important because of the intermediate host. Thus, some tapeworms infesting human beings have cattle or pigs as their intermediate hosts in which the intermediate stage is found in the connective tissue of the muscles ; some tapeworms of the dog require cattle, sheep, horses or pigs as their intermediate hosts in which they cause considerable damage. Examples are cysts, containing the developing worms, in the liver, lungs and

(Photo by Courtesy FAO Rome)

Freezer-drier operated by veterinarian.

muscular tissues of infested animals causing the condition known as hydatidosis, which also occurs in man and one which invades the brain and spinal cord of sheep, causing "gid" or "sturdy".

Round worms are also parasitic in the respiratory tracts of cattle, sheep, pigs and horses. In each of the species of animals, different worms are involved: all give rise to verminous bronchitis. Lung worm infestation in cattle is a very serious problem in some countries, while sheep also suffer to a considerable extent in some parts of the world. The infesting worms of cattle, sheep and horses all have a simple life cycle. The adult worms in the air passages of the lungs produce eggs which are coughed up into the mouth and are swallowed. They hatch in the digestive tract and larvae are passed out in the

faeces, where they develop into an infective stage within a few days under suitable conditions. When ingested in this stage, the larvae pass from the intestine into the lymphatic system and reach the lungs where further development into the adult stage takes place. In the pig, however, the life cycle of the infesting worms is more complicated because various species of earthworms are necessary as inter mediate hosts. In some of the sheep worms, also, intermediate hosts, snails or slugs, appear to be necessary for completion of the life cycle. Cattle lungworms cause bronchitis and typical bronchial pneumonia, while those of sheep cause typical lobar pneumonia. This is an example of closely allied parasites, found in the tissue of different species of animals causing somewhat different types of disease.

Flat worms are also important parasites of domestic animals. Tapeworms have already been mentioned. Another example is the liver fluke of which there are several parasitic species for domestic animals including cattle, sheep, goats, pigs and horses. Human beings may also become infested and liver fluke disease is common in rabbits, deer and some wild animals in some parts of the world. The common parasitic liver flukes have an extremely complicated life history. As the name indicates, the adults are found in the liver, where eggs are laid, pass to the intestine and so are passed out in the faeces. In many species, for further development, the eggs must be deposited near water so that the newly-hatched stage can come into contact with the variety of snail in which several further stages can develop. Eventually, fully developed larvae escape from the snail and form into a resistant stage in which they may remain alive for many months. This stage is passed usually on aquatic plants and, when eaten by susceptible animals, become located in the alimentary tract. Here the larvae are liberated, penetrate the wall of the intestine, enter the liver through its surrounding capsule and live in the liver tissue where they eventually become adult and the cycle begins again. This is but a brief description of the highly complicated life history and also illustrates the many risks to which the parasite is submitted during its life cycle and before it can infest animals. There are several parasitic species of liver fluke, varying in size and different varieties of snails are required as intermediate hosts. Although many species of liver flukes are associated with water snails, some require land snails.

Liver fluke disease is the cause of heavy losses in some areas of the world where conditions exist for development of the parasite and the required snails. The disease is seasonal in character and the likely incidence can often be forecast from weather conditions at certain times of the year.

Some round worms have peculiar selective locations in the organs of domestic animals. An example is a round worm in the kidneys and the walls of the ureters of pigs, where eggs are laid and pass out in the urine. They soon hatch into larvae which become infective in a few days. On being ingested by pigs, the larvae pass through the wall of the intestine and migrate to the liver, finally finding their way to the kidneys and ureter where the adults develop.

Heartworm infection in dogs, common in some countries, is another example. The adult worms live in the right ventricle of the dog's heart, where they may remain for several years. Eggs actually hatch in the female worm's uterus from which the embryos pass into the blood stream of the dog and may remain there for long periods. Intermediate hosts, in the form of insects, e.g., mosquitoes, are necessary for further development of the parasites into the infective larvae which travel to the mouth parts of the biting insect : the infective larva is transmitted to the dog by bites of the insect.

Another example is the parasite which causes trichinosis in man and some animals. Part of its life cycle is passed in the form of an encysted larva in the striated muscles, common sites being the diaphragm, tongue and intercostal muscles. Such uncooked infected meat is the source of infection for man and animals, wild and domestic, like carnivors and pigs. Rats, wolves and foxes are also infected. The encysted larva is liberated in the small intestine of the animal consuming the infected meat and soon becomes mature there. The fertilised female penetrates the lining of the intestine and produces liying larvae, which are carried by the blood and lymphatic systems to the various organs and tissues where they become encysted.

There are many external parasites of domestic animals. Various species of flies are parasitic and may, in addition to causing damage by annoyance and loss of blood, convey mechanically the causal agents of some infectious diseases. Horse flies (Tabanus) which, except in the adult stage, are aquatic or semi-aquatic, lay their eggs near water and the young larvae find food in the water and mud, where they may remain for long periods before pupating in drier soil. Some species of mosquitoes have been known to attack livestock in such large numbers as to cause actual death, but more commonly, lowered production. A most interesting part is played by a species of the mosquito in the transmission of the condition " torsalo " in some South and Central American countries. The fly " Dermatobia hominis " fastens its eggs to the mosquito. As the mosquito feeds on cattle, the eggs hatch and the liberated larvae bore into the skin and cause much irritation and damage, often resulting in the death of the infested animal, if treatment is delayed.

Mosquitoes are also known to convey the virus of fowl pox.

Stable flies and horn flies are blood suckers and may account for some anæmia in attacked livestock, when excessive numbers infest them over a period.

Ox warble flies, of which there are two main species, " Hypoderma lineatum " and " Hypoderma bovis ", are important parasites because of the damage their larvae causes in the hides of cattle and buffaloes. The eggs are fastened to the hairs of the leg and lower parts of the body. Hatching takes place in a few days and the larvae burrow directly into the skin. They then travel into and through various parts of the body, apparently through the connective tissue in which they have been found in many organs. The routes taken by the larvae of the two species seem to differ, but eventually both arrive in the connective tissue of the back where a breathing pore is made and typical " warbles " develop. After some weeks, the warbles squeeze through the pores and fall to the ground where they pupate and become adult flies in a month or two. The life of the adult flies, which do not feed at all, is only a few days.

The larval stages of several species of blowfly infest the wool and skin of sheep. Although wool, soiled by faeces, attracts the flies to deposit their eggs sometimes, in the absence of any soiled wool, specially in wet or moist hot weather, the insfestation takes place. The maggots hatch out from the deposited eggs, attack the wool and, if not controlled, feed on the skin and even the flesh. Failure to attend to infested sheep may mean a considerable death rate in some seasons. In addition to sheep, the flies may use carrion of various kinds in the completion of their life cycle.

The sheep nostril fly is troublesome in some areas. Living larvae are produced and are quickly deposited near the nose from where they find their way into the nasal passages of the sheep where they develop and may remain for long periods. Eventually the fully developed larva leaves the nose, falls to the ground where pupation takes place followed, in due course, by the adult stage.

Very heavy losses may follow screwworm infestation of livestock in parts of America. Screwworms are the larvae of a species of blowfly. Adult flies deposit eggs at the edge of a wound : the eggs soon hatch and the resulting larvae enter the wound and become buried in the animal's flesh, where they feed on the living flesh and complete this stage of development in a few days. On reaching the ground pupation takes place with eventual development of adult flies. The time taken to complete the life cycle may be a few weeks or longer, depending upon the climatic and other conditions.

Infestation of livestock with the various species of ticks may cause heavy losses. In addition to the important diseases which ticks transmit and which will be discussed in a later article, ticks themselves cause losses in production from the irritation they set up, from the removal of blood during their feeding and from abscess formation in the infected hosts. The sheep ked, sometimes erroneously called a tick, passes its entire life cycle on sheep. Each female ked produces only one fully-developed larva at a time and during her life about fifteen may be deposited. Losses from infestation by keds are caused by irritation, interference with wool growth and removal of blood during feeding.

Lice are common on the different animal species, including poultry, eggs are fixed to the hairs or feathers and in a few weeks a new generation of lice is evolved.

All species of livestock are liable to be infested by mites, which cause mange or scabies. Although the species of the infesting mites are very similar in all animals, the actual variety of the species differs in the various types of animals. The three important manges are sarcoptic, psoroptic and chorioptic, each caused by different species of mites. In horses and pigs sarcoptic mange is the most severe, but the other two also occur ; while in sheep it is generally the psoroptic mite which causes scabies or sheep scab. In many countries, scabies in horses and sheep is a notifiable disease and the treatments officially applied have resulted either in eradicating the diseases or in reducing the incidence to a marked extent.

Another mange, demodectic mange, also caused by a variety of mite, occurs in most types of domestic animals, but except in dogs it is relatively rare. The responsible mite is found in the hair follicles and sebaceous glands of the skin where it gives rise to much irritation.

Fungi also infest the skin of domestic animals and human beings, causing the condition popularly known as ringworm. The types of the responsible fungi vary with the animal, but their method of infestation is very similar and the same variety may be transmitted to another type of animal, including man. Following invasion of the hair and the external parts of the skin, thread-like structures develop and enter the hair follicles where many resistant spores are produced. The infection spreads in a circular manner ; hence the term " ring worm ". Ringworm is found mostly in the winter months in housed animals, e.g., calves, the fungus surviving in the stables from year to year. White comb disease in poultry is also caused by fungus.

From these examples, it can be seen that many of the parasitic infestations present complicated problems, including their control. It

is not the intention of this and other articles in this series to dwell upon the methods of control of animal diseases. Veterinarians throughout the world are well acquainted with the problems and with methods of control, based on the results of research work and experience ; they should be consulted and their advice followed. Animal and pasture managements have considerable bearings on the control of some of the infestations and the use of medicaments externally and internally, occupy an important place in preventing them and in the treatment of infested animals. The successful results of some recent work on the immunisation of cattle against lungworms, in which vaccine containing larvae subjected to X-irradiation is used, is opening up a new field of preventive treatment. The indications are that larvae of other round worms, similarly inactivated, may also produce immunity in a number of other infestations.

VETERINARY EDUCATION

By

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THIS article is not concerned with the different views which, doubtless, will continue to be expressed on the details of the education and training of veterinarians. It is rather a consideration of the general subject in an attempt to show how the education of the veterinarian fits in with the duties he has to carry out in his day-to-day professional life.

In discussing the education and training which any person should receive, the first question to be asked is the purpose for which they are given and the answer must be to qualify him for his calling.

It has often been said that veterinarians are guardians of the health of animals: to that might be added that they are also, in some measure, guardians of human health in so far as it is influenced by health of animals.

This means that a veterinarian has a very wide range of duties for which he must receive training. Some specialisation on a single subject or a group of subjects may be part or the whole of a veterinarian's activities: nevertheless, the object in pre-graduate veterinary education is not to produce specialists but men and women whose training has reached a point when further experience or any necessary post-graduate education and training will enable them satisfactorily to carry out the work required of them. On graduation, a qualified veterinarian is often required to engage in much of the practical veterinary field work associated in the country where his education took place.

Intelligence, common sense and scholastic ability are requirements for veterinary students, as for any student. A solid background of general education up to university entrance standard is essential and some acquaintance with basic and natural sciences, obtained either as part of the school education or by other means, is an advantage.

Although a young man or woman has shown the necessary aptitude for acquiring knowledge through education, it does not follow that they will become competent veterinarians. A leaning towards a scientific career, with an interest in animal life, go far to ensure successful results of their education as veterinarians. A fallacy which no longer holds good was that those who had led a rural life and had been closely associated with animals in their earlier days would become the more satisfactory veterinarians. Young men from urban areas were not encouraged to enter veterinary schools. It has been shown many tims that, given the necessary state of mind, aptitude and determination of objective, too much stress need not be given to the general background of a student's early years. Many who have advanced far in the veterinary profession were not intimately concerned with animals and their habits before they entered veterinary schools.

In giving advice to and selecting a prospective veterinary student, the types of work which he will be required to undertake after graduation should be explained to him, so that he will understand and appreciate them and will not be disappointed and, probably, somewhat embarrassed when he has them to carry out. A period of some weeks or months spent on a farm with livestock after the decision has been made to enter a veterinary school and before commencing serious studies, may be necessary in some cases. Prospective students must be made to realise that they may be required to occupy highly responsible posts in the future, and that on them may depend, to some considerable extent, the future welfare and economic position of a country in so far as concerns animal production.

Veterinary schools or colleges exist in many countries : some countries, on the other hand, depend upon foreign schools and colleges for the education of their students. Where, for economic or other reasons, it may not be possible to set up a veterinary school in a particular country and the required veterinarians have to be trained abroad, particular attention has to be given to the choice of the foreign school from the point of view of language, with which the student should be well acquainted.

The administration of veterinary schools and colleges differs throughout the world. Many of the older schools began as independent undertakings through the activities of enthusiastic and far-seeing individuals, often receiving financial support from association and societies interested in agricultural and livestock activities. Many of these schools have now been absorbed into universities or agricultural schools and are receiving government financial support. In many

countries veterinary schools or colleges are integral parts of universities, often complete faculties, enjoying all the privileges and amenities associated with universities. There are many advantages in veterinary schools being faculties of universities not the least of which is the daily close association with students reading other subjects in preparation for other types of professional life. This close association engenders a good understanding of the work to be carried out in different walks of life and tends towards better citizenship. Teachers of veterinary subjects also profit by their contacts with teachers of other subjects and the veterinary and other professions ultimately benefit.

The duration of a veterinary course various according to teaching circumstances and conditions. In some countries the student enters at once into the veterinary school where all the subjects, including the basic sciences, are taught; in other schools the basic sciences are taught before the student enters the veterinary school proper. No matter how or when these subjects are taught they must receive adequate attention for the laying of a sound foundation on which to build instruction in the more advanced and applied sciences. The basic and some parts of the more advanced science subjects are often taught jointly with students of pure science, natural science, medicine and dentistry. The classes may be held in other faculties of the university, in other schools or in the veterinary school.

This general association between students in the early years of their training has some distinct advantages. The teaching of any subject or part of a subject specially concerned with veterinary science must, however, be in the hands of veterinarians who are well acquainwith the specific subject and who have had experience in its teaching. There is much to be said in favour of introducing some practical work in the handling of animals and the general principles of animal management early in the student's career.

This article will not refer to the actual subjects taught in a veterinary school. It is sufficient to say that the general opinion now, gained in many countries over the years, is that subjects should be arranged in groups and that the teaching of one group should be such that it leads conveniently and with good understanding into the teaching of the next group.

It is necessary to test the progress made by students in the different subjects. This is usually done by holding periodic examinations while the subject is being taught—class examinations—and by examinations covering the whole of the subjects of a group—professional examinations—in which written papers and practical tests are required. The

class type of examination is normally carried out by the teachers of the subjects, while it is quite common to have both external and internal examiners for professional examinations. It is of considerable importance in judging a student's knowledge of any subject at professional examinations to give full consideration to his class performance as shown by the results of the periodic class examinations.

Human and veterinary medicine have much in common with regard to the diagnosis, prevention and treatment of disease : many of the techniques are similar and, for treatment, similar medicaments are often used. There is, however, one great difference : while all the resources of science and medicine are used in every effort to preserve human life, economic considerations have to be taken into account to a marked extent in veterinary medicine. Prevention of the spread of some infectious diseases of animals may demand a slaughter policy. The ultimate value of an animal from a production point of view often decides whether treatment or destruction will be carried out. Veterinarians have to advise individuals and governments on measures which will result in the greatest economy to the individual or to the country. Some sentiment does, sometimes, enter into the work : this, however, mostly concerns domestic pets. Veterinarians have also the duty of advising on the precautions to be taken for the prevention of the introduction of animal diseases into a country : it is often on such advice that legislation is made and enacted.

Veterinarians are required to deal with the health and diseases of many species of all animals in which there are many essential differences : the construction of their body systems, their feeding, the details of their digestive and reproductive processes, many of their diseases and the response to some drugs and medicaments all differ. Hence veterinarians must have a wide knowledge of details of all the typical species and their education must prepare them to appreciate and deal with these differences. In veterinary education the horse has received much attention in the past. Although, in some countries, the horse is still an important animal in agriculture and other activities, generally speaking, throughout the world, it is being gradually replaced by mechanical power. With the drive to increase animal production, more and more attention is being directed to the health of other livestock and poultry and veterinary education is now directed more to these subjects. More attention is being given to nutrition and especially to the disorders which may follow nutritional errors ; and to reproduction and the correction of conditions which interfere with regular breeding. The large increase of the poultry industry has demanded a better understanding of the relationship to health of the conditions under which poultry have to be maintained to produce economic results.

The increase, in many countries, of the interest taken in dogs and cats and the high value placed on many of them has meant a better understanding of their health and disease problems. The impetus given to the control of human health with relationship to disease which may be transmitted by infected animals and animal products has led to more importance being attached to the part played by veterinarians in public health. The health of wild animals in zoological gardens and parks is now largely under veterinary control and this arrangement has increased vetrinary activity in this further direction. These and other changes have meant some alterations in some aspect of veterinary education and training, with which veterinary schools and colleges have had to deal.

Some aspects of animal husbandry are included in the work of veterinarians. There have been indications in the past that animal husbandry should not come within the sphere of veterinary activities, and that the work of veterinarians should be confined to sick and diseased animals. In veterinary work throughout the world, prevention of disease now occupies a place even more important than curing disease. The influence which unsatisfactory practices of some parts of animal husbandry can have on animal health and, consequently, on animal production is well known and there are many examples. In order that these influences can be fully dealt with, it is essential that veterinarians are familiar with the wide field of animal husbandry. This does not mean that the entire subject of animal husbandry should necessarily come within the province of veterinarians. In some countries this has actually been done and the veterinarians are responsible for the details of all animal husbandry work, including nutrition, breeding and production. Under such circumstances, specially trained personnel, who are not veterinarians, carry out much of the day-to-day work concerned but the ultimate responsibility to the country is in the hands of the veterinarians. Arguments in favour and against such a system can be put up and, no doubt, such arguments will continue for many years. Accepting that veterinarians are the custodians of animal health, a position which is now freely admitted, thy must understand fully all the aspects of animal husbandry which have a bearing on any departure from good animal health and be able to advise on the necessary changes for their prevention. This is why animal husbandry must be one of the major subjects taught in all veterinary schools and colleges ; and why it is necessary to include much practical training in pre-graduate veterinary education, and why the possession of an independent farm, with all species of livestock, is the ideal being aimed at by many veterinary schools.

Proficiency in clinical medicine is another essential requirement of veterinarians for much of his work concerns the early recognition of any departure from health in animals and any evidence of symptoms, however slight, which might lead to an early diagnosis of the cause of illness and to the measures to be adopted for an accurate diagnosis. Much information can be acquired from textbooks and lectures but the facility to make accurate observations is often part of an individual's natural ability. Even with such natural ability, experience is necessary and the more experience obtained during pre-graduate education, the more will this faculty of observation be developed. For this purpose, therefore, much practical clinical instruction has to be provided at clinics where sick and injured animals are available at all times. There is also much advantage in having an ambulatory clinic attached to a veterinary school, enabling the students to visit healthy and sick animals in their natural surroundings. The practice of handing over the care of sick animals to individual students for observation, and eventual diagnosis and treatment, under the supervision of an experienced clinician of the school staff, encourages the development of observational acumen and confidence. The early recognition of evidence of some infectious disease of animals on a farm or in an area may result in early measures to prevent spread and so be of considerable economic value to a country.

The theoretical and practical training in many veterinary schools is augmented by a requirement that the student gains further experience in the field before he graduates as a veterinarian.

While the course of study pursued by veterinary students is designed largely to fit them for field work and as a basis for the many duties required of them, preferences for different types of work within the veterinary profession are shown by some students even in their pre-graduate days. This is quite natural and a choice of a subject may be the outcome of either the man's own inclination or may be influenced by teachers and others with whom he comes into contact during these impressionable pre-graduate years. It is not always easy to give advice on specialisation but, undoubtedly, those who may be asked to advise take into consideration the aptitude of the young person for the chosen subject. It has to be appreciated that up to the time of graduation the teaching and training and the experience gained by the student has enabled him to acquire and develop his faculties along the required lines. Whether or not a newly-graduated veterinarian who intends to specialise should begin to do so immediately after graduation or whether he should acquire some further general experience has been debated many times in many quarters. It is probably in order to

express the opinion here that experience would indicate that a year or two of further general veterinary field work has some advantages, no matter in which subject the young veterinarian intends to specialise. Practice and experience in the ability to observe carefully and to make deductions from observations is essential in all branches of the veterinary profession : there is no better way of acquiring proficiency than by experience in this field.

In some countries today the small numbers of veterinarians and the relatively few veterinary students who graduate each year makes it necessary for young graduates to decide, even during their student days, on the branch of the profession in which they will work on graduation. The conditions in the country demand this for in these countries some veterinarians have to undertake specific duties. This position has led to some specialisation during the later part of the general veterinary education course. While this may be necessary under present condition, it is to be hoped that as more veterinarians become available in these countries it will be possible to defer all specialisation until graduation has taken place and even until some further experience in general field activities has been obtained.

There are several lines open to veterinarians for specialisation. The part played by veterinarians in public health is increasing throughout the world : specialists in the different aspects of the subject, including slaughterhouse work, are needed at an increasing rate. The preparation and production of biological products for the control of animal diseases is now commonly carried out in individual countries and veterinarians engage in the required laboratory and field work. Teachers of veterinary subjects are required in increasing numbers. Investigation and research work on the many subjects concerned with animal health is being encouraged in all countries. Veterinary administration is demanding more and more capable personnel. All these and other specialist duties fall within the province of veterinarians and all require specialist training. In research work the field is extensive and specialists in different subjects are being encouraged. Some of these subjects are so extensive that specialisation in a single part may be necessary. In many countries some facilities exist for training specialists : they vary very much according to the state of advancement of veterinary education and the work of the profession. There are considerable advantages in some part of the post-graduate education and training along specialist lines being carried out in another country where appropriate facilities are available. In any arrangements for such training abroad it is necessary to ensure that the trainee is well acquainted with conditions in his own country, so that the results of his training may be so amended that they can be applied to the local

problems. Governments and interested national and international organizations are being encouraged to provide the ways and means to enable veterinarians to undergo any necessary specialist training in other countries.

Veterinary services have many responsibilities in all countries. Much of the day-to-day work is carried out by graduate veterinarians in countries in which many of them are available. In such countries, many veterinarians have private practices and attend to the requirements of their individual clients. Governmental veterinary services exist in all countries. Some are extensive, employing many full-time veterinary personnel as well as the part-time services of veterinarians in practice : some, on the other hand, are but a skeleton which, it is hoped, will form the nuclous of a more extensive service as opportunities permit. In countries especially where few veterinarians are available, the service employs lay personnel, trained for special duties, working under the direction and, usually, the supervision of veterinarians. This specially trained staff is performing much good work and is indispensible in many parts of the world where, doubtless, the service will be continued, probably, for all time. Even in the countries with large numbers of veterinarians, lay staff, well trained and experienced, are used, sometimes to a marked extent as, for example, in veterinary laboratories, for technical work in artificial insemination, for carrying out agglutination tests for the diagnosis of pullorum disease in poultry, etc. Such staff, following adequate training and experience become highly specilised in the somewhat narrow field of their activity and, working under supervision of veterinarians, relieve them of some duties which, otherwise, they themselves would have to carry out.

Systems of veterinary education are not static. The basic principles will remain for all time but, as further duties are undertaken by veterinarians, so will their education be altered and improved to meet the conditions.

METEOROLOGICAL REPORT

Summary for January to March, 1960

GENERALLY mild Northeast Monsoon conditions prevailed over the Island during January with light to moderate rain in the north and east and among the hills and occasional scattered evening thundershowers in the southwest. Two short spells of widespread rain, due, to the convergence zone running across south Ceylon and the existence of a short-lived mild low pressure system near the Island, were experienced from 13th to 14th and from 20th to 23rd. The greater monthly totals of rainfall (ranging from 20 to 30 inches) occurred along the eastern slopes of the central hills, while the least rainfall (totals below 2 inches) occurred in the central portion of the western coastal area. Rainfall was mainly below normal in the west and in the North Central region, but generally above normal elsewhere. The larger excesses (of the order of 5 of 12 inches) were experienced in the south and east. There were about 25 daily falls over 5 inches during the month.

During February there was an unusual wet spell from the 19th to the 27th causing widespread floods in the Eastern and North Central provinces. This rain was due to a wave of low pressure lying across the Island. Two spells of practically dry weather were experienced from the 2nd to 7th and 16th to 18th. Mild Northeast Monsoon Weather prevailed during the rest of the month, with scattered thundery activity in the southwest quarter. The greater monthly totals of rainfall (totals over 30 inches) occurred in the East, particularly along the eastern slopes of the central hills. Least rainfall (totals below 5 inches) occurred in the west and extreme north. Rainfall was above normal particularly in the east. There was only one report of a deficit rainfall. The larger excesses (of the order of 40 inches) were experienced along the eastern slopes of the central hills. There were nearly 80 daily falls over 5 inches.

The Northeast Monsoon grew weaker during March and a few scattered evening thundershowers were felt in the southwest quarter and among the hills. Light to moderate thundershowers were fairly widespread on the 9th and 10th when a moderate easterly current was found to blow across the Island. Again on the 30th and 31st wet

weather prevailed over most parts of the Island as a result of a shallow trough of low pressure off Southeast Ceylon and fairly active convergence. The greater monthly totals of rainfall (totals over 15 inches) occurred in the Southwestern low country. The greater part of the Island received less than 2 inches of rainfall, while about 10 stations received no rain at all. The rainfall was below normal over most of the Island, the larger deficits (of the order of 10 inches) being recorded along the slopes of the central hills. No daily falls over 5 inches were reported during March.

D. J. JAYASINGHE,
Acting Director.

Department of Meteorology,
Bullers Road,
Colombo-7, June 3, 1960.

Meteorological Report for the Quarter January to March, 1960

JANUARY

	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	Number of days
Anuradhapura ..	84·2	+0·8	71·1	+1·9	79	95	3·09	—2·71	14
Badulla ..	77·3	+1·1	64·7	+0·9	83	94	14·05	+3·73	22
Batticaloa ..	82·7	+1·2	74·1	+0·5	83	93	17·03	+4·15	17
Colombo ..	86·8	+0·4	72·3	+0·5	73	85	1·84	—2·12	4
Diyatalawa ..	72·2	+0·4	59·2	+1·5	82	91	8·37	+1·73	25
Galle	83·5	—0·3	74·2	+1·2	79	90	4·06	+0·18	9
Hambantota ..	84·9	0	73·4	+0·8	74	88	1·46	—2·54	13
Jaffna ..	82·9	—0·1	74·0	+1·9	78	90	6·07	+1·66	10
Kandy ..	81·7	—0·5	66·0	+1·1	73	89	6·73	—0·01	12
Kankesanturai ..	82·3	—0·5	75·6	+0·7	80	86	6·37	+2·96	11
Kurunegale ..	86·9	+0·5	70·6	+0·8	72	95	1·65	—3·46	8
M'Illuppallama ..	84·6	+1·1	69·9	+0·8	76	93	5·22	—0·32	15
Mannar ..	83·3	0	76·3	+2·1	76	84	1·97	—1·87	11
Nuwara Eliya ..	68·1	+0·3	50·3	+3·2	76	84	5·83	—1·13	16
Puttalam ..	86·0	+0·5	71·8	+1·8	71	88	0·83	—2·60	11
Ratmalana ..	88·2	+1·2	72·8	+1·4	69	88	2·17	—1·98	6
Ratnapura ..	89·7	+0·4	72·1	+1·0	70	90	6·26	0	12
Talawakele ..	72·8	+0·6	56·7	+1·3	78	76	4·33	+0·46	14
Trincomalee ..	81·6	+1·1	75·7	+0·4	79	84	18·15	+9·84	20
Mullaitivu ..	82·4	—	76·6	—	80	84	1·96	—3·50	12
Vavuniya ..	84·3	—	70·5	—	75	95	2·38	—4·06	15

FEBRUARY

	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	Number of days
Anuradhapura ..	84·4	—2·8	70·0	+0·7	78	95	5·98	+4·26	13
Badulla ..	76·7	—2·2	65·0	+1·9	84	94	17·76	+14·59	19
Batticaloa ..	81·9	—1·0	73·9	+0·2	82	93	26·03	+21·82	17
Colombo ..	86·6	—0·5	72·2	+0·2	69	85	6·82	+4·22	10
Diyatalawa ..	72·1	—2·8	58·7	+1·8	83	94	10·49	+8·12	15
Galle	84·1	—1·0	74·0	+0·4	77	90	7·12	+3·83	11
Hambantota ..	83·7	—2·2	73·0	0	78	90	6·95	+5·49	10
Jaffna	83·6	—2·0	73·0	+0·8	75	93	5·82	+4·36	9
Kandy	81·7	—3·7	66·6	+2·3	74	89	12·40	+10·01	14
Kankesanturai ..	83·8	—0·9	75·2	+1·2	76	84	2·25	+1·17	8
Kurunegala ..	86·0	—3·9	70·4	+0·9	72	95	4·98	+2·99	12
M'Illuppallama ..	84·3	—3·2	68·9	+0.9	80	97	7·66	+5·75	11
Mannar ..	84·1	—2·0	74·7	+0·9	78	90	2·77	+1·07	8
Nuwara Eliya ..	67·8	—1·8	50·4	+5·1	74	87	8·88	+6·89	17
Puttalam ..	86·9	—1·4	71·2	+1·0	66	88	2·57	+1·20	8
Ratmalana ..	87·5	+0·1	72·4	+1·1	70	90	5·90	+2·54	14
*Ratnapura ..	84·7	—	69·0	—	72	90	12·69	+7·39	18
Talawakele ..	89·1	—2·5	71·5	+0·2	74	83	8·63	+6·66	16
Trincomalee ..	71·0	—5·4	57·1	+2·7	77	82	12·09	+9·44	13
Mullativu ..	81·7	—0·8	75·8	0	76	82	8·92	+7·59	8
Vavuniya ..	83·0	—	75·9	—	74	95	6·60	—4·87	8

	MARCH								
	Temperature				Humidity		Rainfall		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps)	Total	Offset	Number of days
Anuradhapura ..	91·1	—0·4	71·6	0	65	93	0·40	—3·75	2
Badulla	83·2	+0·8	64·3	0	71	94	0·74	—4·31	7
Batticaloa ..	85·4	0	75·2	+0·1	74	91	4·45	+0·98	7
Colombo	87·5	—0·3	73·6	—0·4	69	90	2·73	—1·93	7
Diyatalawa ..	79·2	+1·6	57·1	—1·1	68	88	1·13	—3·76	8
Galle	86·5	+0·2	75·4	+0·4	72	86	0·96	—4·35	9
Hambantota ..	86·3	—0·7	74·4	+0·1	72	88	2·09	—1·30	8
Jaffna	88·1	—0·6	75·4	—0·5	68	91	0·06	—1·52	2
Kandy	86·6	—1·3	66·9	—0·2	63	92	1·24	—4·18	7
Kankesanturai ..	87·9	—0·8	74·6	—0·7	68	88	0·57	—0·90	1
Kurunegala ..	92·8	+0·1	71·8	—0·2	60	98	0·23	—6·05	7
M'Illuppallam ..	90·7	—1·3	69·6	—1·9	66	95	0·82	—3·82	4
Mannar	88·7	—0·6	75·3	—0·2	70	71	0·09	—1·75	1
Nuwara Eliya ..	72·2	+1·3	44·5	—2·1	63	82	0·67	—3·42	6
Puttalam ..	90·3	+0·4	72·7	—0·2	64	88	2·12	—0·96	4
Ratmalana ..	88·7	+0·5	74·4	+0·5	68	90	3·34	—3·14	7
*Ratnapura ..	92·5	+0·4	72·1	—0·4	65	88	4·89	—5·49	18
Talawakele ..	75·5	—2·3	54·3	—1·1	62	81	3·51	—1·11	9
Trincomalee ..	86·8	—1·2	76·8	+0·2	71	84	2·34	+0·04	7
Mullativu.. ..	85·9	—	74·7	—	73	90	2·02	+0·34	5
Vavuniya.. ..	90·8	—	69·9	—	62	93	0·72	—2·12	3

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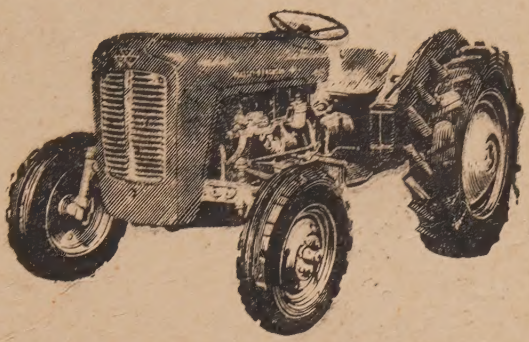

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